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Index of Contents

List of Tables

Chapter I:

Issues in Executive Compensation:

An Introduction

1.1 Background

The central problem of agency theory is first raised by Berle and Means (1932). In their well-known and frequently-cited book "The Modern Corporation and Private Property", they argue that the separation of ownership and management of the corporation would inevitably lead to divergence of interest between shareholders and managers. The managers will not act as the shareholders expectation due to the divergence of interest. More specifically, Berle and Means (1932) wrote:

> *"…have we any justification for assumption that those in control of a modern corporation will also choose to operate it in the interests of the owners? The answer to this question will depend on the degree to which the self-interest of those in control may run parallel to the interests of ownership and, insofar as they differ, on the checks on the use of power which may be established by political, economic, or social conditions... If we are to assume that the desire for personal profit is the prime force motivating control, we must conclude that the interests of control are different from and often radically opposed to those of ownership; that the owners most emphatically will not be served by a profit-seeking controlling group."*[1]

Intuitively, the owners' profits are not maximized in most cases because shareholder value maximization is not the objective of manager. Jensen and Meckling (1976) establish an economic model of principal-agent problem and analyze it formally. They define the severity of the principal-agent problem as the agency cost, which is the aggregate of principal's monitoring cost, the agent's bonding cost, and principal's

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[1] Berle, Adolf A., and Gardiner C. Means, 1932. "The Modern Corporation and Private Property", (Macmillan Publishing Co., New York), p.113-114.

welfare loss due to the deviations of agent's decisions from the optimal decisions[2]. Jensen and Meckling (1976) show that the level of managerial ownership is positively related to firm value, when managerial ownership is low. They also point out, however, that a certain level of managerial ownership could aggravate the agency problem as managers might be incentivized to entrench themselves and be involved in rent extracting.

Literature in agency problem is exploding after these seminal studies.

1.2 Literature Review

1.2.1 Optimal Contracting Hypothesis

Since the existence of agency problem is well acknowledged in academic and business society, a natural research question is how to alleviate the problem and lower agency costs. Among the studies in agency problem and executive compensation, many of them claim a competitive equilibrium interpretation of the contracting outcomes either implicitly or explicitly, assuming that equity incentive is an efficient tool to alleviate agency problem and to maximize firm value. This view is commonly known as the optimal contracting hypothesis.

As shown in Jensen and Meckling (1976)'s simple principal-agent model, the manager's decisions are not optimal from the shareholders' point of view, because the manager and the shareholders have different objectives. They argue that awarding manager with firm shares will mitigate the inconsistency in objectives and lower shareholders' welfare losses. In addition, they provide evidence that firm value is positively related to managerial ownership, when managerial ownership is low. But

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[2] Optimal to the principal, in the sense that those decisions maximize principal's welfare.

they also point out that a certain level of managerial ownership could aggravate the agency problem. Following this line of attack, researches focusing on analyzing the relationship between managerial ownership and firm performance arise.

Demsetz and Lehn (1985) propose that managerial ownership is non-linearly related to firm size and firm risk. They argue that the monitoring costs are higher for firms with more volatile stocks, hence executives should be rewarded by more firm shares to be incentivized. On the other hand, executives tend to hold less stocks when stock return are too volatile since executives are assumed to be risk averse. Therefore, there exists an "optimal level of managerial ownership". In addition, the "optimal level of managerial ownership" is higher for larger firms. Morck, Shleifer, and Vishny (1988) estimate a piecewise-linear relation between board ownership and firm performance measured by Tobin's Q. They find that firm performance first increases with managerial ownership because of the incentive alignment effect of stock ownership, when managerial ownership is at a low level between 0% and 5%. This incentive alignment effect becomes weaker as the level of managerial ownership increases and the entrenchment effect increases. They report a negative relationship between firm performance and managerial ownership when managerial ownership lies between 5% and 25%, which indicates that entrenchment effect dominates in this region and top executives would spend firms' wealth to entrench themselves rather than investing in the most profitable projects. When the manager owns more than 25% of firm stocks, the incentive alignment effect dominates again and firm value increases with managerial ownership. McConnell and Servaes (1990) examine a large sample contains 1,173 firms for 1976 and 1,093 firms for 1986, and find an inverted U-shaped relationship between managerial ownership and firm performance, with the optimal managerial ownership lying between 40% and 50%, which maximizes shareholder welfares. Holderness, Kroszner, and Sheehan (1999) compare 1,500 publicly traded U.S. companies in 1935 and 4,200 exchange-listed firms in 1995, and find that the average managerial ownership has increased from 13 percent in 1935 to 21 percent in 1995. The use of incentive-pay compensation also increased from 1935 to 1995. Accompanied with the increase in managerial ownership, no significant difference is found in the strength of board monitor, or market for corporate control between these two samples. They conclude that managerial ownership has not been used as a substitute for other mechanisms designed for mitigating agency problem. When analyzing the relationship between managerial ownership and firm performance, they find a piecewise linear relationship similar to Morck, Shleifer, and Vishny (1988) in their 1935 sample, and this relationship becomes weaker in their 1995 sample.

As shown in Demsetz and Lehn (1985), the "optimal level of managerial ownership" varies with firm size, therefore assuming exogenous managerial shareholding is not convincing. Himmelberg, Hubbard, and Palia (1999) suggest that managerial ownership is endogenously determined by firms' observable and unobservable characteristics. Using a panel data setting and controlling for the firm fixed effects, they show that managerial ownership is affected by observable and unobservable firm characteristics and the results are consistent with the principal-agent model. Furthermore, they show that the effect of managerial ownership on firm performance is undetermined after firm observable and unobservable characteristics are controlled. Cui and Mak (2002) study the same problem with a sample consisting high R&D firms only, and report a W-shaped relationship. Their findings suggest that industry effects have a non-negligible effect on the contracting environment and hence affect the equilibrium of managerial holdings. Teshima and Shuto (2008) construct a theoretical model to study the relationship between managerial ownership and earning management behavior of managers to extract excessive rents. Their model suggests that earnings management is less likely when managerial ownership is either at a low level or a high level, and more likely at an intermediate level of managerial ownership. Analyzing data of Japanese firms, they report piecewise linear relationship consistent with the model's prediction.

Core and Larcker (2002) analyze a sample of firms which require their managers to hold a certain amount of company stocks from 1991 to 1995. They find that both managerial ownership and stock returns are lower than their industry peers before the adoption of such "target ownership plans", and both measures increase substantially after the plan adoption. They argue that "target ownership plans" can improve corporate governance and incentivize managers. In another attempt to disentangle the co-movement and infer for causal relationship, McConnell, Servaes, and Lins (2008) examine the stock price movements in response to the announcements of changes in insider holdings, and an inverted-U shape is reported. They conclude that change in insider ownership have an impact on firm value. Coles, Lemmon, and Meschke (2012) specify a structural model where managerial ownership, firm size, and firm performance are jointly determined endogenously. They also find an inverted U-shaped relationship between managerial ownership and firm performance. They argue that instead of being a tradeoff between incentive alignment and entrenchment effects, this inverted-U shape merely comes from the co-movement of firm performance and managerial ownership. They further suggest that the variable affecting both firm performance and managerial ownership is marginal productivity of investment.

Besides the researches in the relationship between managerial ownership and firm performance, another stream of studies focuses on the relationship between executive compensation and firm performance, i.e. the pay-for-performance sensitivity. Murphy (1985) applies the panel data setting and control for the firm fixed effect in estimating the relation between executive compensation and firm performance. He reports a strong positive relation between executive pay and firms' stock return. He also provides evidence that large firms tend to pay their executives more than smaller firms, but the return of larger firms are lower. Mehran (1995) studies the executive compensation structures of 153 firm using data from 1979-1980, and analyzes the relationship between executive compensation and firm performance. He finds a positive relation between managerial ownership and firm performance, using Tobin's Q and return on assets as proxies. In addition, the percentage of equity incentives in executive total compensation is also found to be positively related to firm performance. Interestingly, Mehran (1995) shows that managerial ownership for an executive is negatively related to the percentage of equity incentives in his compensation packages. Jensen and Murphy (1990) collect data of executive stock holdings data from 430 large companies' proxy statements in 1987, and show that CEO wealth changes $3.25 in response to $1000 change in shareholder wealth, i.e. the estimated pay-for-performance sensitivity to be 0.325%. They decompose the effect and show that only 0.075% wealth changes are arise from the sum of performance related compensation such as stock option grants and threat of dismissal. Hall and Liebman (1998) study a sample of large U.S. firms in 1994 and estimate that average CEO wealth increases $25.11 in response to a $1000 increase in shareholder wealth. The corresponding value change in stock options is $3.66. Both measures are significantly larger than Jensen and Murphy (1990)'s estimations, indicating that CEOs' wealth are more strongly related with firm performance. In Murphy's later survey (Murphy (1999)), he estimates the pay-for-performance sensitivity again using S&P 500 company data from 1996, and shows that the pay-for-performance sensitivity increased to about 0.6%. Regardless of the increase in pay-for-performance sensitivity, he still argues that both estimated magnitudes are too low to be consistent with principal-agent theory.

Core and Guay (1999) develop a theoretical model to analyze the optimal equity compensation for CEOs, and argue that the optimal equity compensation depends on firm characteristics such as firm size, growth opportunities, and monitoring costs. Furthermore, since the optimal equity compensation levels may vary over time and the value of firm equity in executives' portfolio change over time, the alignment effect of the optimal equity compensation may become weaker as time passes. Another interesting and intuitive evidence they present is that the aggregate amounts of stocks and stock options in CEOs' portfolio are better measurement than only considering CEOs' stock ownership, as the explanatory power of equity incentive are substantially larger when using total stocks and options as proxy for equity incentives. Palia (2001) takes executive compensation as endogenously determined and shows that controlling for the firms' unobservable heterogeneity has an impact on the relation between firm performance and executive equity incentives. He reports an inverted U-shaped relationship between executive compensation and firm performance when applying OLS estimation, but this relationship is statistically insignificant when he applies the instrumental variable estimation, using CEO experience, CEO age, CEO education quality and firm volatility as instruments. Habib & Ljungqvist (2005) explicitly estimate the "theoretical optimal contracting level" and compare it with actual executive compensation in U.S. companies between 1992 and 1997. They find a positive relation between firm value and CEO stock holdings, and a negative relation between firm value and option holdings, i.e. firms are away from their optimal contracting levels by awarding their CEOs too little stocks and too many options.

The mixed results of these comprehensive studies imply that optimal contracting hypothesis may be incompetent in explaining executive compensation. As the dominating hypothesis is confronted with various challenges, some researchers introduce an alternative hypothesis (the managerial power hypothesis which will be discussed in the next section), yet more researchers attempt to explain these seemingly inconsistencies and further extend the optimal contracting hypothesis.

A stream of studies provided by optimal contracting defenders argue theoretically and show empirically that the alignment effect of equity incentives varies with firm risk and so is the optimal contracting level. Garen (1994) analyzes the determinants of the level and structure of executive compensation using Jensen and Murphy (1990)'s data. He presents two versions of principal-agent model and predicts that the structure of executive compensation is a tradeoff between incentives and firm risk. His evidence indicates that for firms with more variable profitability, the correlation between executives' equity-based compensation and firm performance is lower, which confirms the prediction of his model. Using a significantly larger dataset, Aggarwal and Samwick (1999) provide similar evidence that the volatility of firms' stock return is negatively correlated with pay-for-performance sensitivity. They further argue that this is because CEOs in firms with more volatile stock returns tend to hold smaller amounts of firms' shares. Jin (2002) analyzes a theoretical model and predicts that when the CEOs are allowed to trade the market portfolio, the optimal incentive level is negatively correlated with firm-specific risks. Using a large data set from 1992 to 1998, he provides empirical evidence confirming the negative relation between risk and incentive levels. The non-significant relation between market risk and incentive levels suggests that CEOs can adjust their exposure to market risks. Guo and Ou-Yang (2006) establish a theoretical model in which the manager's utility also depends on his own wealth, and the manager is able to affect not only the firm's expected return but also the firm's risk. They demonstrate that under such settings, the relation between firm value and incentive levels may be either positive or negative, depending on the manager's utility function.

Another stream of studies attempts to relate the seemingly-too-high compensation to firm size. Baker and Hall (2004) present a model and show that how pay-for-performance sensitivity is related to firm size depends on how CEO decisions affect firm value. They estimate the marginal product of CEO effort with respect to firm value to be 0.4, which means that CEO's good effort will partially increase firm value. They also show a weakly negative relation between CEO incentives and firm size. Gabaix and Landier (2008) establish and analyze an equilibrium model in which the CEOs are not paid for their efforts but instead paid for their managerial expertise. They show that in market equilibrium, the most talented CEOs work for the largest firms, and are highest paid. In their model, executive compensation depend not only on firm size, but also on the distribution of firm size in the market. Intuitively, when more firms in the market become larger, more managers, talented or not, get higher pay in equilibrium. Cao and Wang (2009) propose a dynamic equilibrium agency model where CEOs are allowed to search for better outside opportunities. Analyzing the model equilibrium and empirical evidence, they show that both CEO compensation and firm size are increasing with the growth of general economy. He (2011) embeds the optimal contracting problem into the cash flow framework commonly used in capital structure model, in order to take the "debt-overhang" effect into consideration. After deriving the equilibrium of the model, among other results, they find that the manager's pay-for-performance sensitivity is negatively related to firm size.

Many other factors, such as industry, institutional investor ownership, monitoring intensity, market structure, and executive ability, are found to be influential on the executive incentives and optimal contracting level. Ittner, Lambert, and Larcker (2003) analyze a sample of new economy firms and show that high-technology firms offer significantly more stock options than manufacturing firms to compensate and incentivize their CEOs. They also report that the pay-for-performance sensitivity varies across organizational levels. Hartzell and Starks (2003) show that the pay-for-performance sensitivity of executive compensation is positively related with institutional investor ownership concentration, even after controlling for important factors such as firm size, industry, investment opportunities and firm performance. They also report a negative relation between the level of executive compensation and the concentration of institutional ownership. They argue that a large institutional investor is able to monitor the manager more efficiently and mitigate the agency problem. Hermalin (2005) alleges that the monitoring power of boards and large shareholders is positively related to executive pay. He argues that when strengthening monitoring power increases the CEO's threat of being fired, the optimal contracting level should be increased accordingly.

Falato and Kadyrzhanova (2008) establish a competitive equilibrium model of CEO compensation and industry dynamics. They show that for industry leaders, the optimal incentive levels are lower. This result follows from the logic that manager in industry leader expects the space for product improvement is limited and hence lowers his effort level. They also show a positive relation between optimal incentive levels and competition intensity in the industry, because growth opportunities for such firms are higher, therefore the equilibrium of effort level and incentive levels increase accordingly. Analyzing data of U.S. corporations from 1993 to 2004, they provide empirical evidence supporting their predictions. Graham, Li, and Qiu (2012) sophisticatedly research the effects of firm specific characteristics and individual specific characteristics on executive compensation structures. They show that firm size, growth opportunities, tenure of the executives, and being at the CEO position are all positively related to the level of executives' total compensations. In addition, they also show that individual heterogeneities such as ability have an impact on executive pay.

Although early established and often challenged, the optimal contracting hypothesis remains one of the most popular concepts to explain executive compensation and financial contracting. The aforementioned studies comprise only a small selection of the researches that contribute to the development of the optimal contracting hypothesis, and the literature is still evolving.

1.2.2 Managerial Power Hypothesis

Unlike optimal contracting hypothesis, which assumes that remuneration committee of the board can design a sophisticated compensation plan to lower the agency costs caused by the self-interested managers, an alternative view suggests that the managers themselves have influences on their compensations and practically aggravate the agency problem. Bebchuk, Fried, and Walker (2002) first elaborate this idea and label it as the "managerial power hypothesis", but the emergence can be traced back much earlier.

Some tentative evidences are offered by David Yermack. In his early attempt to test certain implications of optimal contracting hypothesis, Yermack (1995) analyzes option awards data of 792 U.S. firms from 1984 to 1991. His results indicate a negative relationship between option awards and growth opportunities, which is a direct contradiction to the prediction of optimal contracting hypothesis. Other results of this article fail to support the optimal contracting hypothesis either. In his later study, Yermack (1996) finds that as the size of the broad increases, both firm performance and the thread of CEO dismissal decrease. This is interpreted as larger and less efficient board leads to inferior performance. Meanwhile, he reports a positive relation between managerial ownership and firm value. Studying the timing of CEO stock option awards, Yermack (1997) finds that the timing of option awards coincide with company stock price increases due to good news releases. He takes this result as an evidence of powerful managers influencing their own compensations. Ofek and Yermack (2000) study the relation between stock compensation and managerial ownership, and find that managers tend to sell shares they already own if they are rewarded with firms' restricted stocks. They also provide further evidence that managers would continue selling shares in the future if they are compensated by more equity incentives or if the firms' stock price increase substantially. Therefore, they argue that top executives are managing their personal diversified portfolio and would adjust their holdings of firm's shares according to market conditions and their newly received stock awards.

Bebchuk, Fried, and Walker (2002) claim that the optimal contracting hypothesis is not sufficient in explaining some of the observed evidence in the market, especially the surge of executive compensation in 1990s. Their main argument is that managers can influence their own compensation plans through influencing the board. In addition, they suggest that manager tend to extract excessive pay by camouflaging their compensation, such as replacing cash wages by the excessive amounts of option awards, because options are difficult to value, and are not required to be disclosed in detail at that time. They name this inefficiency in contracting as the "managerial power hypothesis". Bebchuk and Fried (2003) offer managerial-power explanations for some empirical findings which are puzzling under the optimal contracting framework. For example, they report an inverse relation between CEO incentive compensation and firm size, and argue that this can be well explained by CEO entrenchment.

Poor governance is the most often cited cause of managers obtaining unjustified high power and allowing rent extraction. Bertrand and Mullainathan (2001) analyze an equilibrium model based on optimal contracting hypothesis and predict that managers should not be rewarded by luck under optimal contracts. But their empirical evidence indicates that CEOs are in fact rewarded by lucks. Furthermore, they show that firms with better corporate governance systems reward their CEOs less for luck. Cheng and Warfield (2005) study the relation between managers' equity incentives and managers' future trading and earnings management using data from 1993 to 2000. They find that for those managers who received high equity incentives, selling shares are more likely after earnings announcements. They provide further evidence that managers with higher equity incentives are associated with higher frequencies in meeting or beating analysts' forecasts. Combining these results, they claim that high equity incentives lead to earnings management, as the managers are motivated to boost stock prices and profit from selling over-priced firm shares. Yermack (2006) studies CEO's personal use of company planes, and shows that average shareholder returns are 4% lower than market benchmarks for firms that have disclosed such excessive perquisites. This is in line with managerial power hypothesis as personal use of company planes is perceived as weak corporate governance. Another anecdotal evidence they provide is that having a long-distance golf club membership has a strong positive effect on the use of company planes. Bebchuk, Grinstein, and Peyer (2010) study the option grant practices from 1996 to 2005 for the options granted at the lowest price, which they name as the "lucky" grants. They show that the "lucky" grants are deliberately timed to increase their value. In addition to CEOs, independent directors are also found to be receiving "lucky" grants. For CEOs in a firm without an outside blockholder on board, and for the firms with a long-serving CEO, "lucky" grants are more prevalent.

The inefficiency arise from weak corporate governance may be an indication of demands for stricter regulatory restrictions. Chhaochharia and Grinstein (2009) find that CEO compensations are negatively affected by stricter regulations. Controlling for firm size, performance, and unobservable firm characteristics, the negative effect is found to be stronger on the firms which are more severely affected by the regulations. Also, for firms without an outside blockholder on board and for those without a large institutional investor, the CEO compensations decrease more after the new regulations apply. Their results suggest that regulation requirements can effectively strengthen corporate governance and reduce the excessive compensation of influential managers. Acharya and Volpin (2010) establish a managerial labor market model where firms can choose their corporate governance quality. They show that firms with weaker corporate governance compensate their managers more than deserved. More importantly, firms with good corporate governance are forced to raise their executive compensation to compete for qualified managers. The existence of negative externality of poor corporate governance serves as a theoretical appeal for stronger regulation on corporate governance standards.

Many responses from the supporters of optimal contracting hypothesis arise soon after Bebchuk, Fried, and Walker (2002)'s book on managerial power hypothesis, including some direct challenges. Murphy and Zabojnik (2004) show that compared to internally-promoted CEOs, who are assumed to be more influential in the firm, outside-hired CEOs receive higher compensations. They analyze a model and suggest this result arises from the market condition that general management skills are more valuable than firm-specific managerial skills. Furthermore, managers with higher general management skills face more potential employers who are competing against each other. Therefore their wages are higher in equilibrium. This article responses to Bebchuk, Fried, and Walker (2002)'s argument that optimal contracting hypothesis is not able to explain the substantially-increased compensations in 1990s, with a view point directly contrary to the managerial power hypothesis. Aggarwal and Samwick (2006) analyze the equilibriums of two principal-agent models to examine how the agency problem affects firm investment. Using ExecuComp data from 1993 to 2001, they find that firm performance is monotonically increasing in incentives. Investment is also found to be increasing in incentives, which contradicts to the predictions of managerial power hypothesis that managers are overpaid and personally profit from over-investing. These results are robust to the inclusion of firm observable and unobservable characteristics. They suggest these results indicate the problem of under-investing exists, and could be solved by rewarding managers with optimal contracts.

Except for excessive rent extraction, option awards are also accused to be inducing too much risk taking in firm operations. Rajgopal and Shevlin (2002) collect and analyze data of firms in oil and gas industry from 1992 to 1997. They find that for CEOs holding stock options, the sensitivity of option value to stock price volatility is positively related to the firm's future risk taking. Intuitively, they claim that stock options provide CEOs with incentives to make risky investments. Coles, Daniel, and Naveen (2006) find that controlling for CEOs' pay-for-performance sensitivity, firms with higher sensitivity of CEO wealth to stock volatility is associated with higher business risks. In specific, the R&D investments are higher, the investment in fixed capital is lower, the business is less diversified, and the leverage is higher for those firms with CEOs' wealth more closely related to stock return volatility. These combined show that CEO whose compensation is more closely related to stock price volatility makes riskier decisions.

As an attempt to respond to the argument that option awards are over-used, Armstrong, Larcker and Su (2007) specify an agency model where manager's effort can affect all moments of stock returns, i.e. the mean, the volatility and higher order moments. After solving the model and estimating the parameters with Fortune 500 firm data between 2000 and 2004, they show that stock options are almost always part of the optimal contracts. Bizjak, Lemmon, and Naveen (2008) analyze the effect of competitive benchmarking on CEO compensations. Using data from 1992 to 2005, they show that for the CEOs moved from below-median-paid to over-median-pay, compensation increases are associated with better firm performance and tighter labor market conditions, but not related to poor corporate governance. Their findings reject the argument that competitive benchmarking is inappropriately used for managers to ensure compensation not relating to firm performance.

The debate over optimal contracting hypothesis and managerial power hypothesis is always heated as either one is theoretically superior or empirically better supported than the other. Only a very limited number of selected studies are mentioned in this dissertation[3]. Unless a model can be established where testable predictions could be derived to distinguish between the two hypotheses, or a comprehensive model that incorporate both hypotheses properly and firmly supported by empirical evidence, the debates will be on-going. However, treating these two hypotheses as competing alternatives has not been productive. More and more researchers[4] admit that these two hypotheses are not mutually exclusive and both forces exist in the realistic contracting environments.

1.3 Motivations and Contributions

In this dissertation, I attempt to offer updated evidence of the relationship between managerial ownership and firm performance (Chapter II), the relationships between equity incentives and firm performance (Chapter III), and the determinants of executive compensation structures (Chapter IV).

1.3.1 Motivations

The field I am trying to contribute is filled with developed researches. A huge amount of studies exist and the literature is still growing. It is well recognized that the

[3] For the interested readers, please see the surveys of Edmans and Gabaix (2009) and Frydman and Jenter (2010) for a more detailed and in-depth discussions about the recent theoretical and empirical evidence for and against these two mainstream hypotheses.

[4] See, for example, Frydman and Jenter (2010) and Murphy (2012).

amounts of equity incentives and firm performance are jointly determined in the contracting environments, and so are managerial ownership and firm performance. Important factors which are believed to be simultaneously affecting equity incentives, managerial ownership, and firm performance have been controlled for in existing studies, such as firm size, stock return volatility, importance of fixed capital, R&D intensity, and firm- and personal unobservable characteristics.

However, another important factor, firm performance from last period has long been ignored. A normal firm's current performance is likely to be affected by its past performance, as business operation is a continuous process and the momentum effect exists, stronger or weaker. Managerial ownership is also affected by firm performance since manager is likely to take past firm performance into consideration when he manages his own portfolio and makes holding decisions. The amounts of stocks and options in executive compensation package are likely to relate to past firm performance, because the firms may adjust the equity incentives they reward their executives considering their performance from last period, the influential managers may also ask for higher payments in forms of stocks and options after a good year. Therefore, past performance has impacts on managerial ownership, equity incentives, and current firm performance. These effects should be appropriately accounted for. To my knowledge, existing studies fail to include firm performance dynamics either in analyzing the relationship between managerial ownership and firm performance, or in analyzing the relationship between equity incentives and firm performance.

In an attempt to fill in the blanks, Chapter II researches the effects of previous firm performance and managerial ownership on firm performance using dynamic panel setting, by exploring firm-level data of all firms in the S&P 500, the Midcap 400, and the Smallcap 600, from 1992 to 2009. Chapter III scrutinizes the effects of previous firm performance, executive stock awards, and executive option awards on firm performance using dynamic panel settings, using data from the same firms and same time span as in Chapter II, but in manager-level[5]. These two chapters are seemly overlapped, probably because managerial holdings and equity incentives are used as synonyms in some papers, especially in some theoretical paper and in the verbal discussion parts of some empirical studies. But these two concepts differ substantially in essence, as shown in the following equation.

$$M_{i,t} = M_{i,t-1} + Stock_{i,t} + Option_{i,t,t-n} + Net\ Investment_{i,t}$$

where $M_{i,t}$ is the amount of firm stocks[6] manager i holds in time t; $Stock_{i,t}$ is the amount of firm stock awards manager i receives as part of her compensation in time t; $Option_{i,t,t-n}$ is the amounts of firm stocks manager i gets in time t, as a result of exercising the option awards she received as part of her compensation in time t-n; Net $Investment_{i,t}$ is the amount of firm shares manager i buy or sell in time t, taking her personal investment portfolio into consideration.

Managerial ownership, $M_{i,t}$, is a state variable, which describes how many firm stocks is currently in the executive's private portfolio. It is affected by not only by stock awards and option awards she gets from the company as part of her remunerations, but also by her own investment decisions, Net $Investment_{i,t}$. As argued by Ofek and Yermack (2000), top executives are managing their own diversified portfolios and hence would adjust their holdings of firm's shares. Jin (2002) also suggests that executives can adjust their exposure to market risks by trading firm shares and other stocks.

Equity incentives, $Stock_{i,t}$ and $Option_{i,t+n,t}$, are flow variables. They describe by how much the manager's wealth is increased as rewards for her hard working during the period, in the form of stocks and options. In the view of optimal contracting hypothesis supporters, these amounts are decided by how the board would like to

[5] In both Chapter II and Chapter III, contemporaneous relationships between managerial ownership and firm performance, and between equity incentives and firm performance estimated using the common static panel settings are also reported. These parts are not the main motivations and innovations of these chapters though.

[6] All "firm stocks" here stand for the stocks of the firm manager i is working for.

incentivize the manager. In the view of managerial power supporters, these amounts are decided by how influential the manager is in determining her own compensation.

Due to the differences in natures of managerial ownership and equity incentives, their relationships with firm performance can also differ essentially. Therefore separate studies are necessary and helpful in understanding the contracting dynamics.

Besides relating managerial ownerships and equity incentives to firm performance, another important research question is the determinants of executive compensations. In fact, the endless debate between optimal contracting camp and managerial power camp roots in the question that how is executive compensation determined. The effects of firm- and manager characteristics on the level of executive compensations have been extended studied. However, little is known about the effects of these factors on the compositions of executive compensations, i.e. different forms of compensations as a percentage of total compensation. Chapter IV studies the effects of various factors, firm- and manager specific, observable and unobservable, on the executive compensation structures from 2006 to 2009. Scrutinizing the factors influencing the relative importance of different forms of executive compensation may offer some helpful implications for understanding the contracting practices.

1.3.2 Summary of Main Findings

In Chapter II, I find that managerial ownership is negatively related to firm size and firm stock volatility. Firm fixed effects also have an impact on managerial ownership. When analyzing the relationship between managerial ownership and firm performance using the common static panel settings, an inverted-U shape is reported, and this relationship is robust to the inclusions of firm fixed effects. However, when firm performance from last period is also included in the estimations, the inverted U-shaped relationship between contemporaneous managerial holdings and firm performance vanishes. I conclude that managerial ownership and firm performance are co-determined, and the previously located inverted-U shape is spurious because both managerial ownership and firm performance are affected by firm past performance.

Chapter III reports several interesting findings in the relationships between equity incentives and firm performance. When using static panel specifications, I find that firm performance is increasing at decreasing rates with the option awards for executives from 1992 to 2009, but no statistically significant relation is found between executives' stock awards and firm performance in this period. The evidences with lagged- and differenced equity incentives are mixed. Firm- and individual unobservable effects are correlated with equity incentives and other firm variables, and hence should be properly accounted for. When firm performance from last period is also included in the analyses, only the concavely positive relationship between option awards and firm performance remains statistically significant in the sample from 1992 to 2005.

The evidences provided in Chapter IV are manifold. Among other findings, I show that younger and older executives receive more current compensation but less equity incentives. In addition, CEOs receive larger portions of equity incentives and long-term performance bonus than non-CEO executives. For executives in above-average firms in the industry, their compensation packages consist of less current compensation and stock options, but more non-equity incentives. Some other factors such as gender, firm stock return volatility, R&D intensity are also shown to have certain impacts on the importance of some compensation forms.

1.3.3 Contributions

The contributions of this dissertation are as follows. Firstly, in analyzing the relationship between managerial ownership and firm performance and the relationships between stock awards and option awards and firm performance under static panel settings, I provide empirical evidence with a large number of firms in a long period. As discussed in the literature review section, the long list of researches studying these questions offer mixed evidence. The various evidences provided by current researches are partly due to the fact that they are analyzing different samples. In an attempt to update the understandings in these questions, I apply the commonly used static panel settings on a sample consisting of all firms in the S&P 500, the Midcap 400, and the Smallcap 600, from 1992 to 2009.

Secondly, I present the relationship between managerial ownership and firm performance, and the relationships between equity incentives and firm performance after controlling for past firm performance. As discussed previously, current firm performance, managerial ownership, and executive equity incentives are all likely to be related with firm performance from the last period. It is likely that the previous identified relationships are biased or even spurious, because the effect of lagged performance has been omitted. Applying dynamic panel setting and including firm performance from last period in the analyses can help us to identify how the relationship between managerial ownership and firm performance and the relationships between equity incentives and firm performance are affected by lagged performance, and as a consequence enhance our understandings of inter-temporal contracting dynamics.

Thirdly, I decompose the effect of stock awards and option awards on firm performance. The common practices of analyzing the effect of equity incentives on firm performance are aggregating the value of stock awards and option awards and estimating the joint effect. But aggregating the two simply neglects the differences in the natures of stock awards and option awards, which is not convincing because the payoff structures of stocks and options to managers differ substantially. The differences in nature and payoff structure will likely lead to different effects on firm performance. In this study, I estimate the effects of stock awards and option awards to firm performance separately.

Fourthly, I offer an example of applying difference GMM and system GMM in empirical studies of executive compensations. The endogeneity problem is a haunting issue for empirical researchers, especially for those in the field of executive compensations. Financial economists have been struggling to find valid instruments to control for endogeneity, but this issue could never be perfectly solved since almost every variable is closely related to the others in the modern business environments. Those meticulously designed econometric methods such as difference GMM and system GMM may be productive alternatives to the dominant methods such as within estimator and instrumental variable regressions. Among the empirical evidence provided by dynamic panel settings, test results show that the applications of difference GMM and system GMM in my studies are valid.

Finally, I offer some evidence on the determinants of relative importance of various forms of compensations in executive remuneration plans. The essential conflict between optimal contracting hypothesis and managerial power hypothesis is whether executive compensation is a solution to agency problem or it is the source of agency problem. By analyzing the factors influencing the portions of different compensation forms in executives' total compensation, some implications of how the composition of executive compensation is decided can be inferred from the empirical evidence provided.

1.4 Limitations and Future Researches

1.4.1 Limitations

The studies included in this dissertation are empirical studies. Rather than establishing theoretical models and proposing new theories in executive compensations, the intentions of these studies are to offer updated evidence describing the current status in certain issues of executive compensations and enhance our understandings in this field. Besides offering updated evidence, two main limitations exist in these empirical studies.

Firstly, the reported evidences are not able to distinguish between optimal contracting hypothesis and managerial power hypothesis. Actually, many findings can be explained by both hypotheses. For example, the concavely increasing relationship between executive option awards and firm performance can be interpreted as executives are currently under-incentivized and firms should offer their executives more options awards to increase firm performance (optimal contracting hypothesis). Meanwhile, it is equally possible that executives have some inside information about the firm's future performance and accordingly offer themselves more option awards (managerial power hypothesis). These studies fail to offer testable predictions that can distinguish between the two hypotheses, or the relative importance of the two hypotheses in the market data.

Secondly, no causal relationship could be claimed on the located relationships. The reported evidences only describe the current status of the relationships between several variables. Any interpretation as causal relationship is merely conjecture. For the same example in Chapter III, the positive relationship between option awards and firm performance is sometimes elaborated as "a concavely positive effect of option awards on firm performance", implying that option awards incentivize executive to improve firm performance. However, the true effect may also be that the well-performing firms tend to reward their executives with more options. Therefore the reported relationships should be interpreted with cautions.

1.4.2 Future Researches

The Tradeoff between Optimal Contracting and Managerial Power

As the debates around optimal contracting hypothesis and managerial power hypothesis will continue, a potential fruitful field for theoretical economists is to establish a comprehensive model that incorporates both hypotheses.

From my point of view, the two hypotheses are complementary to each other in the dynamic games between shareholders and managers. The remuneration committee of the board, assuming they fulfill their responsibility of due diligence and act solely on behalf of the shareholders, will try to offer the manager a contract that maximizes the shareholders welfare (optimal contracting hypothesis), while the manager and his consultant will endeavor to contract for maximal excessive wages and perquisites (managerial power hypothesis). The agreement they reach is then an outcome of the bargaining of these two sides and a tradeoff between optimal contracting and rent extraction. In essence, the controversy between the two hypotheses lies in the assumptions on bargaining powers of the shareholders and managers. Optimal contracting hypotheses implicitly assumes that the market for managing ability is competitive and the supply side of managing ability is abundant, shareholders therefore have the market power and can make a contract that maximizes their welfare. Managerial power hypothesis, on the other hand, assumes that managerial expertise is scarce, hence managers have the bargaining power and enable themselves to extract excessive rents. The changes in conditions of the managerial expertise market lead to changes in bargaining powers of shareholders and managers, and therefore change the contracting dynamics.

An economic model taking the market conditions of managerial expertise market into consideration can integrate the two hypotheses. The supply of managerial expertise in such a model serves as a parameter of the relative importance of optimal contracting hypothesis and managerial power hypotheses. Establishing and analyzing such models can be potentially fruitful for theoretical economists in this field. By estimating such models with data, empirical researchers could also answer the long disturbing question: why some empirical evidence is in favor of the optimal contracting hypothesis, while some others support the managerial power hypothesis.

Non-Equity Incentives

In addition to the unsettle questions in executive compensation, non-equity incentives may be a new but especially interesting field for future researches.

Non-equity incentives are a type of cash payments which focus on long-term performance, usually based on three-year or five-year horizons' cumulative performance. They can be seen as "long run bonus", in the sense that they are cash payments when the performance criteria were satisfied. Chapter IV reports evidence showing that for executives in over-industry-average firms, non-equity incentives comprise larger portions in their total compensations. In addition, the portions of non-equity incentives in executive compensation plans are positively related to the firms' investment costs, and negatively related to firms' free cash flows. The interpretations are twofold as the causal relationships are not clear. It is possible that executives receiving more non-equity incentives will make more profitable investments, keep less cash, and improve firm performance. It may also be the case that the over-performing firms use their cash flows more efficiently, and attempt to avoid over-risky behaviors from executives by rewarding them more non-equity incentives. More interpretations are possible, and any one of them can be an intriguing research question.

Compared to equity incentives, non-equity incentives have a unique advantage as being flexible in terms of incentive objective. Equity incentives affect executives' payoff only through stock prices, therefore executives are only incentivized to boost firm stock prices. If executives are rewarded with too many out-of-money options, they may also invest in over-risky projects in attempts to increase stock prices and make their options profitable. Non-equity incentives can be designed to relate to various performance measures other than focusing on stock prices or accounting profits. The meticulously designed performance measures and benchmarks may also involve the welfare of other stakeholders, thereby driving executive efforts to other specific directions.

Non-equity incentives deserve being more extended studied. However, data on non-equity incentives are still limited, because disclosing these data are only required after the SEC adopted the new disclosure requirements from 2006. Empirical researches focusing on this specific topic are foreseen to be arising in the near future. Theoretical researches such as design of incentive mechanism can also be potentially fruitful.

Chapter II:

Does Managerial Ownership really have an Impact on Firm Performance?

Empirical Evidence using Static and Dynamic Panel Settings

2.1 Introduction

Agency problem is a key issue in corporate governance. Berle and Means (1932) allege that the separation of control rights from the ownership of a firm leads to inconsistency in incentives between managers and shareholders, and shareholders' wealth are not maximized by the managers' decisions. In an attempt to alleviate this agency problem, top managers are usually awarded with shares of the firms they are working for. By offering managers with firm stocks and requiring them to hold these stocks, the manager's personal wealth will be more closely related to firm's stock return, and the agency cost will be lowered. To test how effective is managerial ownership in mitigating agency problem, a common practice is analyzing the relationship between firm performance and managerial holdings. Examining different samples, previous researches offer mixed evidence.

This chapter follows the same line of attacks and studies the relationship between managerial ownership and firm performance. It is well accepted that managerial ownership and firm performance are jointly determined and are both affected by firms' and manager's characteristics. To avoid the omitted variable bias, many important variable affecting both firm performance and managerial ownership have been controlled for in the existing researches, such as firm size, stock return volatility, R&D intensity, and firm- and personal unobservable characteristics. However, an important variable has long been ignored, which is firm performance from last period. A firm's current performance is likely to be affected by its past performance, while the manager is also likely to take past firm performance into consideration when he makes his holding decision. Therefore, past performance has impacts on both managerial ownership and current firm performance, and its effect should be appropriately accounted for. To my knowledge, existing studies fail to include firm performance dynamics in the relationship between managerial ownership and firm performance. In an attempt to fill in the blank, this chapter studies the effects of previous firm performance and managerial ownership on firm performance using dynamic panel setting, by exploring all firms in the S&P 500, the Midcap 400, and the Smallcap 600 from 1992 to 2009. I also provide the empirical results under static panel settings by replicating Himmelberg, Hubbard, and Palia (1999)'s paper with a substantially larger sample.

Briefly summarizing the main findings of this chapter, I find that managerial ownership is negatively related to firm size and firm stock volatility. Firm fixed effects also have an impact on managerial ownership. When analyzing the relationship between managerial ownership and firm performance using the common static panel settings, an inverted-U shape is reported, and this relationship is robust to the inclusions of firm fixed effects. However, when firm performance from last period is included in the estimations, the inverted U-shaped relationship between contemporaneous managerial holdings and firm performance vanishes. I conclude that managerial ownership and firm performance are co-determined, and the previously located inverted-U shape is spurious because both managerial ownership and firm performance are affected by firm past performance.

The contributions of this chapter are threefold. Firstly, I provide empirical evidence under static panel settings with a large number of firms in a long period. The mixed evidence provided by current researches in relating managerial ownership and firm performance are partly due to the fact that these researches are scrutinizing different samples. In an attempt to update the understandings in the relationship between managerial ownership and firm performance, I apply the commonly used static panel settings on a sample consisting of all firms in the S&P 500, the Midcap 400, and the Smallcap 600, from 1992 to 2009. Secondly, I present the relationship between managerial ownership and firm performance after controlling for past firm performance. It is conjectured that the previous identified relationship is spurious, simply because both firm performance and managerial ownership are driven by a same omitted variable. Researchers try to catch the omitted variables by including various proxies, but firm performance from last period has always been ignored.

Because both managerial ownership and current firm performance are likely to be affected by past performance, I include it in the study and offer evidence after it is properly controlled for. Thirdly, I offer an example of applying difference GMM and system GMM in analyzing the relationship between managerial ownership and firm performance. Financial economists have been struggling to find valid instruments to control for endogeneity, since almost every variable is closely related to the others in the modern business environments. Those meticulously designed econometric methods such as difference GMM and system GMM may be productive alternatives to the dominant methods such as within estimator and instrumental variable regressions.

The rest of this chapter is organized as follows. Section 2.2 discusses several influential and related studies. Section 2.3 briefly introduces the econometric methods used and Section 2.4 describes the sample. The empirical results will be presented in Section 2.5 and Section 2.6 concludes.

2.2 Literature Review

Previous researches focus on analyzing the relation between firm performance and managerial holding. Jensen and Meckling (1976) show that the level of managerial ownership is positively related to firm value, when managerial ownership is low. They also point out, however, that a certain level of managerial ownership could aggravate the agency problem as managers might be incentivized to involve in rent extracting. These two opposing effects are known as incentive alignment effect and management entrenchment effect. On one hand, managerial ownership could help align the interests of managers with those of shareholders as assumed, so that a positive relation exists. On the other hand, managers may also exert insufficient effort, collect private benefits and entrench themselves at higher levels of managerial ownership, which lead to a negative relationship between managerial ownership and performance. It is generally not clear that which effect dominates. Though there are some controversies regarding the functional form, empirical studies propose a non-linear relation between managerial ownership and firm performance, which supports both the alignment and the entrenchment effect.

Demsetz and Lehn (1985) propose that managerial ownership is non-linearly related to firm size and firm risk. They argue that the monitoring costs are higher for firms with more volatile stocks, hence executives should be rewarded by more firm shares to be incentivized. On the other hand, executives tend to hold less stocks when stock return are too volatile since executives are assumed to be risk averse. Therefore, there exists an “optimal level of managerial ownership”. In addition, the “optimal level of managerial ownership” is higher for larger firms. Morck, Shleifer, and Vishny (1988) estimate a piecewise-linear relation between board ownership and firm performance measured by Tobin's Q. They find that firm performance first increases with managerial ownership because of the incentive alignment effect of stock ownership, when managerial ownership is at a low level between 0% and 5%. This incentive alignment effect becomes weaker as the level of managerial ownership increases and the entrenchment effect increases. They report a negative relationship between firm performance and managerial ownership when managerial ownership lies between 5% and 25%, which indicates that entrenchment effect dominates in this region and top executives would spend firms' wealth to entrench themselves rather than investing in the most profitable projects. When the manager owns more than 25% of firm stocks, the incentive alignment effect dominates again and firm value increases with managerial ownership. McConnell and Servaes (1990) examine a large sample contains 1,173 firms for 1976 and 1,093 firms for 1986, and find an inverted U-shaped relationship between managerial ownership and firm performance, with the optimal managerial ownership lying between 40% and 50%, which maximizes shareholder welfares. Holderness, Kroszner, and Sheehan (1999) compare 1,500 publicly traded U.S. companies in 1935 and 4,200 exchange-listed firms in 1995, and find that the average managerial ownership has increased from 13 percent in 1935 to 21 percent in 1995. The use of incentive-pay compensation also increased from 1935 to 1995. Accompanied with the increase in managerial ownership, no significant difference is found in the strength of board monitor, or market for corporate control between these two samples. They conclude that managerial ownership has not been used as a substitute for other mechanisms designed for mitigating agency problem. When analyzing the relationship between managerial ownership and firm performance, they find a piecewise linear relationship similar to Morck, Shleifer, and Vishny (1988) in their 1935 sample, and this relationship becomes weaker in their 1995 sample.

Another debating issue about the relationship between managerial ownership and firm performance is endogeneity problem. As shown in Demsetz and Lehn (1985), the "optimal level of managerial ownership" varies with firm size, therefore assuming exogenous managerial shareholding is not convincing. There are many ways to introduce endogeneity to an empirical model, two of them are most frequently cited in executive compensation literatures. One is reverse causality. Under the reverse causality argument, the real effect might be that firm performance would influence the number of shares top managers hold, instead of the opposite. The other is the correlation between regressors and error terms, e.g. unobservable individual characteristics. Certain omitted variables affecting firm performance are also likely to affect some of the regressors. In this case, OLS would be biased.

Himmelberg, Hubbard, and Palia (1999) suggest that managerial ownership is endogenously determined by firms' observable and unobservable characteristics. Using a panel data setting and controlling for the firm fixed effects, they show that managerial ownership is affected by observable and unobservable firm characteristics and the results are consistent with the principal-agent model. Moreover, they show that the effect of managerial ownership on firm performance is undetermined after firm observable and unobservable characteristics are controlled. They also provide further evidence supporting the causal relationship from ownership to firm performance when using a two-stage specification, but this evidence suffers from weak instrument problems. Cui and Mak (2002) study the same problem with a sample consisting high R&D firms only, and report a W-shaped relationship. Their findings suggest that industry effects have a non-negligible effect on the contracting environment and hence affect the equilibrium of managerial holdings. Teshima and Shuto (2008) construct a theoretical model to study the relationship between managerial ownership and earning management behavior of managers to extract excessive rents. Their model suggests that earnings management is less likely when managerial ownership is either at a low level or a high level, and more likely at an intermediate level of managerial ownership. Analyzing data of Japanese firms, they report piecewise linear relationship consistent with the model's prediction.

Core and Larcker (2002) analyze a sample of firms which require their managers to hold a certain amount of company stocks from 1991 to 1995. They find that both managerial ownership and stock returns are lower than their industry peers before the adoption of such "target ownership plans", and both measures increase substantially after the plan adoption. They argue that “target ownership plans” can improve corporate governance and incentivize managers. In another attempt to disentangle the co-movement and infer for causal relationship, McConnell, Servaes, and Lins (2008) examine the stock price movements in response to the announcements of changes in insider holdings, and an inverted-U shape is reported. They conclude that change in insider ownership have an impact on firm value. Cole, Lemmon, and Meschke (2012) specify a structural model where managerial ownership, firm size, and firm performance are jointly determined endogenously. They also find an inverted U-shaped relationship between managerial ownership and firm performance. They argue that instead of being a tradeoff between incentive alignment and entrenchment effects, this inverted-U shape merely comes from the co-movement of firm performance and managerial ownership. They further suggest that the variable affecting both firm performance and managerial ownership is marginal productivity of investment.

This chapter studies the relation between managerial ownership and firm performance by exploring all listed firms in North America from 1992 to 2009. To my knowledge, existing studies fail to include firm performance dynamics in the relationship between managerial ownership and firm performance, i.e., the effect of previous firm performance on current performance. In an attempt to fill in the blank, this study researches the effects of previous firm performance and managerial ownership on firm performance using dynamic panel setting. I also provide the empirical results under static panel settings.

2.3 Model Specifications

2.3.1 Determinants of Managerial Ownership

The first analysis of this chapter is studying the determinants of managerial ownership. As shown previously, managerial ownerships are affected by many firm variables. Therefore, rather than simply assuming exogeneity in managerial ownership, I assume that they are endogenously determined in the contracting environment, which differs across firms in both observable and unobservable ways.

In addition to the observed characteristics, managerial ownership is also correlated to the firms' unobservable characteristics. Firms' characteristics such as monitoring power of shareholders, intangible assets, and market power are neither observable nor measurable, but are strongly affecting top managers' holding decisions. Therefore omitting these characteristics will lead to misspecification and bias in the estimators. The importance of unobserved heterogeneity in the contracting environment across firms is emphasized in this chapter, therefore the individual fixed effects are included in the model. One feature of this panel data specification is that we can summarize all the unobservable characteristics in the individual fixed effect[7]. Let's assume the following equation represents a good approximate of the true dependence of managerial ownership on firm characteristics and contracting environment (Equation (2.1)):

$$\ln\left(\frac{m_{it}}{1-m_{it}}+0.00001\right)=\alpha_0+\alpha_1{}'\,x_{it}+\upsilon_i+e_{it} \tag{2.1}$$

7 "Individual fixed effect" is a proxy for time invariant characteristics of "individual". "Individual" is referred to either a firm or an industry in this chapter, as we will see in the subsequent sections.

m_{it} is the faction of common equity outstanding held by top executives as a group, x_{it} is a vector of observable characteristics variables, v_i is a variable summarizing the effect of unobservable time-invariant characteristics (the fixed effect), and e_{it} is the error term. Since managerial ownership is defined in the region between 0 and 1, a logic transformation shown above will make the managerial holding variable more suitable as an explained variable of linear regression. To avoid that managerial ownership equal to 0 is excluded in the transformation and hence leads to selection bias, 0.00001 is added.

Two questions of interest could be answered by the empirical evidence from this model. Firstly, the relationship between managerial ownership and the firm's observable characteristics can be located. The observable characteristics here include proxies for potential of moral hazard and risk of the firm. Economic theories predict that these factors would affect top managers' effort levels, and hence their holding decisions. Secondly, the effect of firms' unobserved characteristics on managerial holding decision is studied. The unobserved heterogeneity is usually neglected. This is only justified if they are uncorrelated with managerial ownership, which is not likely in the real business world. This research provides evidence of the effects of firms' unobserved characteristics on managerial ownership, and how neglecting them would lead to biased estimates.

2.3.2 Effect of Managerial Ownership on Firm Performance

The second analysis of this chapter is to examine the empirical links between managerial ownership and firm performance. Previous empirical works proposed different forms of non-linear relationship, but no consensus has been reached so far. Among others, quadratic form and piece-wise linear form are the most often-cited functional forms of the relationship between managerial ownership and firm performance.

As discussed, unobservable firm characteristics are also included in the analysis, to correct for potential endogeneity problem. The detailed functional forms of the models to be estimated are specified as follows:

Specification I (Quadratic Form)

$$Q_{it} = \beta_0 + \beta_1 m_{it} + \beta_2 m_{it}^{\;2} + \beta_3 ' \, x_{it} + u_i + e_{it} \tag{2.2}$$

This specification assumes that firm performance is non-linearly related with managerial ownership, in a relatively simple form. The variables m_{it}, x_{it}, u_i, and e_{it} are defined as above. Q_{it} is the proxy for firm performance and will be more detailed discussed in the proxy variable section.

Specification II (Morck et al. (1988))

$$Q_{it} = \beta_0 + \beta_1 m_{1it} + \beta_2 m_{2it} + \beta_3 m_{3it} + \beta_4 ' \, x_{it} + u_i + e_{it} \tag{2.3}$$

This specification includes three piecewise-linear terms in managerial ownership m, i.e. m_{1it}, m_{2it}, and m_{3it}. They are defined as

$$m_1 = \begin{cases} m; & if \;\; m < 0.05 \\ 0.05; else \end{cases}$$

$$m_2 = \begin{cases} 0; & if \;\; m < 0.05 \\ m - 0.05; & if \;\; 0.05 \le m < 0.25 \\ 0.2; else \end{cases}$$

$$m_3 = \begin{cases} 0; & if \;\; m < 0.25 \\ m - 0.25; else \end{cases}$$

The spirit of this specification is to break the non-linear function into small parts, and then treat each part linear locally.

There are many ways to estimate Equation (2.1), (2.2), and (2.3), with the most widely used ones being OLS and within estimators. Let's take Equation (2.2) as an example. Estimating it with OLS simply ignores the unobservable characteristics, u_i. Weak exogeneity assumption[8] is needed for the OLS estimator to be consistent, in this context, we need $E[X_{it}(u_i+e_{it})]=0$ [9]. Assuming $E[X_{it}e_{it}]=0$, the weak exogeneity assumption holds in this context only when firm unobservable characteristics do not have an impact on firm performance ($u_i = 0$, for all i), or when firm unobservable characteristics are not related to firm observable characteristics and managerial ownership ($E[X_{it}u_i] = 0$). When the later condition holds, random effect estimator (GLS estimator) is consistent and efficient. However, both of these two conditions are too strict, as almost every variable is related to the others in modern business world.

The fixed effect estimator (within estimator) is a feasible and popular alternative solution. It requires only a mild assumption that firm unobservable characteristics are time-invariant, which is acceptable since the most important firm unobservable characteristics affecting both firm performance and firm observable variables are fixed overtime or change extremely slowly, such as corporate governance mechanism and corporate culture. The unobservable fixed effects are cancelled out in within estimator by applying a demeaning process. Let's continue the example of Equation (2.2). Firstly, all variables are summed up overtime and the overtime-mean values for each variable are calculated for each group (Equation (2.4)). Then I demean all variables by subtracting Equation (2.4) from Equation (2.2). Since the unobservable fixed characteristics are time-invariant, the overtime average values equal to the corresponding level values, therefore Equation (2.5) is reduced to Equation (2.6).

$$\overline{Q_i} = \beta_1 \overline{m_i} + \beta_2 \overline{m_i^2} + \beta_3 ' \ \overline{x_i} + \overline{u_i} + \overline{e_i} \tag{2.4}$$

$$\begin{aligned} Q_{it} - \overline{Q_i} = {} & \beta_1 (m_{it} - \overline{m_i}) + \beta_2 (m_{it}{}^2 - \overline{m_i^2}) \\ & + \beta_3 ' \ (x_{it} - \overline{x_i}) + (u_i - \overline{u_i}) + (e_{it} - \overline{e_i}) \end{aligned} \tag{2.5}$$

[8] Since u_i is not explicitly modeled in OLS, the error term is now $\varepsilon_{it}= u_i+e_{it}$, weak exogeneity of ε_{it} is needed for the consistency of OLS estimator.

[9] X_{it} is a vector including all regressors.

$$Q_{it} - \overline{Q_i} = \beta_1(m_{it} - \overline{m_i}) + \beta_2(m_{it}{}^2 - \overline{m_i{}^2}) + \beta_3{}'\,(x_{it} - \overline{x_i}) + (\mathrm{e}_{it} - \overline{e_i}) \qquad (2.6)$$

After this demeaning process the unobservable fixed effects are cancelled out and the OLS estimation for Equation (2.6) is unbiased. The fixed effect estimator is widely used in empirical researches in management science. Its application is appropriate as long as Equation (2.2) is a good approximate of the true relationship between firm performance and managerial ownership.

To check the validity of applying within estimator, I will also carry out two tests to check the two previously raised conditions, i.e. firm unobservable characteristics do not have an impact on firm performance ($u_i = 0$, for all i), or firm unobservable characteristics are not related to firm observable characteristics ($E[X_{it}u_i] = 0$). To check the former, I carry out an F-test with the null hypothesis being $u_i = 0$ for all i. If the null hypothesis is rejected, then firm unobservable characteristics have an impact on firm performance. To check the later, I carry out a Hausman test comparing the estimation coefficients of within estimator and GLS estimator. The null hypothesis of the Hausman test is that the difference in coefficients of within estimator and GLS estimator is not systematic. If the null hypothesis is rejected, then GLS estimator is not consistent and within estimator is consistent and should be used[10].

Besides the convenience, the application of fixed effect estimators has a major drawback. To cancel out the unobservable effects, a demeaning process is carried out as shown above. After this process, only the within group variations are left for estimating the parameters. If the executive compensation components and other firm observable characteristics, manager observable attributes also vary slowly overtime, the left-over variations may be too small to have stable parameter estimates. This potential problem could be solved by including data from longer

[10] However, the Hausman test for misspecification requires the assumption that the within estimator is consistent under both H_0 and H_1, and the GLS estimator is consistent and efficient under H_0 but inconsistent under H_1. Again, this assumption is fulfilled as long as Equation (2.2) is a good approximate of the true relationship between firm performance and managerial ownership. See, for example, Chapter 9 of Greene (2008), Chapter 10 of Woodridge (2002) for more in-depth discussions about OLS, within estimator, and GLS estimator in static panel settings.

periods. Considering the fact that the sample in this study consists of 18 years' data, this theoretical drawback is not a main concern.

2.3.3 Effect of Managerial Ownership on Firm Performance (Instrumental Variable Specification)

Another candidate solution for endogenous managerial ownership is instrumental variable regression. This identification strategy is theoretically perfect for models with endogenous regressors, but only if valid instruments are available. A valid instrument should fulfill two assumptions. Firstly, it is correlated with the endogenous independent variable which needs to be controlled. Secondly, it is uncorrelated with the dependent variable[11]. The later one is particularly harsh in reality. Financial economists have been struggling to find valid instruments to control for endogeneity, but this issue could never be perfectly solved since almost every variable is closely related to the others in the modern business environments.

In the context of this study, an instrument should be a variable which is correlated with managerial ownership, but uncorrelated with Tobin's Q. It is extremely difficult to find such variables, because all factors affecting top managers' contracting decisions could potentially also affect firm performance.

Himmelberg, Hubbard, and Palia (1999) use firm size and stock volatility as instruments. They argue that the inclusion of advertising and R&D intensity and the investment rate already control for the effect of future growth opportunities on firm performance, or in other words, firm size and stock volatility could be neglected in the firm performance regression. Firm size and stock volatility, on the other hand,

[11] Since instrumental variable estimator is not a major estimation strategy in this study, I skip the mathematical assumption and derivation. For more detailed discussions of instrumental variable estimator, see Chapter 12 of Greene (2008), Chapter 5 of Woodridge (2002).

would have some effects on top managers' contracting decisions. However, they fail to provide evidence justifying the validity of their instruments.

In this chapter, I will replicate the idea of Himmelberg, Hubbard, and Palia (1999) and also use firm size and stock volatility as instruments for managerial ownership. The regressions using instrumental variables are carried out in the quadratic specifications. In addition, I will check the validity of these instruments by carrying out the tests for over-identification.

2.3.4 Effect of Managerial Ownership on Firm Performance using Dynamic Panel Setting

The above specifications are all in static panel settings, which neglect the relationship between firm performances in different periods. In this section, I use dynamic panel setting, in order to allow for time dependencies of firm performance. As discussed above, firm performance this period is likely to be affected by its performance from last period. In this case, the functional form (assuming quadratic form) becomes

$$Q_{it} = \beta_0 + \gamma Q_{it\text{-}1} + \beta_1 m_{it} + \beta_2 m_{it}^{\ 2} + \beta_3 ' \, x_{it} + u_i + e_{it} \tag{2.7}$$

with all variables defined as above.

When autocorrelation exists in the model, the within estimator is not consistent anymore. The within estimator solves the problem of the unobserved fixed effects, by demeaning the whole equation and thereby smoothes out u_i. More specifically, the mean values of Q_{it}, Q_{it-1}, m_{it}, m_{it}^2, and all x_{it} for each firm are obtained and subtracted in the original model, in order to obtain the deviation from firm mean for each variable, as shown in Equation (2.8) below[12]. OLS is then carried out on Equation (2.8).

$$Q_{it} - \overline{Q_i} = \gamma(Q_{it-1} - \overline{Q_i})$$
$$+\beta_1(m_{it} - \overline{m_i}) + \beta_2(m_{it}^2 - \overline{m_i^2}) + \beta_3{}'(x_{it} - \overline{x_i}) + (\mathrm{e}_{it} - \overline{e_i}) \qquad (2.8)$$

Since we assume the firm fixed effects are time invariant, the mean of u_i is itself, the unobserved fixed effects are wiped out in the transformed data and hence the omitted variable bias mentioned in pooled OLS is avoided. However, the demeaning process eliminates the firm fixed effects, but at the mean time introduces another endogeneity problem in the dynamic model. The new problem arises due to the fact that Q_{it-1} and its average are correlated with the mean of e_{it}. Nickell (1981) derives the asymptotic bias to be -(1+γ)/(T-1), for large T and the number of observations goes to infinity. This bias does not vanish even for infinitely many time periods, i.e., even for T goes to infinity, the within estimator is still inconsistent.

A comforting fact is that the within estimator and the OLS estimator are biased in opposite directions. For example, when the OLS estimator is biased upwards, the within estimator would be biased downwards (as shown in Nickell (1981)). This gives us a “consistent range”. We can expect that a consistent estimator gives results lying between the estimates from OLS and those from the within estimator.

In dynamic panel setting, several candidate consistent estimators are available. The first candidate considered in this study is the difference generalized method of moments (difference GMM) estimator proposed by Arellano and Bond (1991). The first difference transformation is applied on Equation (2.7) to get Equation (2.9).

$$\Delta Q_{it} = \gamma\Delta Q_{it\text{-}1} + \beta_1\Delta m_{it} + \beta_2\Delta m_{it}^2 + \beta_3\Delta x_{it} + \Delta e_{it} \qquad (2.9)$$

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[12] Please note that the two averages of Q involves different length of time, same notation is used only for simplicity.

where $\Delta e_{it} = e_{it} - e_{it-1}$, and other differenced variables are defined analogously.

Since the stochastic error terms should not have a shock retrospectively, the level of variables before period t-1 should be independent of the differenced error terms. Hence, we can make use of the orthogonality condition $E[W_{it-2}\Delta e_{it}] = 0$, where W can contain the firm performance or all the firm characteristics including managerial ownership variables, or in the most efficient case, all of them. All previous lags, W_{it-3}, W_{it-4}, …W_{i0} are also valid instruments, and thus should be included in the estimation.

The difference GMM estimator can be easily extended to system GMM estimator by including more valid orthogonality conditions and making use of the level equation (Equation (2.7)). The additional orthogonality conditions exploited in system GMM are $E[\Delta W_{it-1} (u_i + e_{it})] = 0$ and those of further lags. These conditions are claiming that the error terms this period should be independent of the changes of the regressors and the changes of dependent variable two periods before and earlier. These new conditions together with the conditions in difference GMM model compose the system GMM estimator.

These two estimators strongly rely on the behavior of the error terms. It is assumed that the error terms are independently distributed over time. Then the differenced error terms, Δe_{it}, should follow an MA(1) process. If independently distributed error term assumption fails to hold, for instance, when the original error terms follow an MA(1) process, the differenced error terms would follow an MA(2) process. This will reject many of the orthogonality conditions used above, and difference GMM estimator and system GMM estimator might not be consistent. Arellano and Bond (1991) introduce the tests for the behavior of the error terms. I will perform these tests when applying the difference GMM estimator and system GMM estimator. In addition, Arellano and Bond (1991) also introduce the Sargan test of over-identifying restrictions to check the validity of orthogonality conditions used. These tests will be carried out and results will be reported in empirical evidence section[13].

By extending the static panel model to dynamic setting, two main questions of interest are studied. Firstly, the relationship between managerial ownership and firm performance would be studied in a more structured way. Top managers are likely to take the firms' historical performance into consideration when making their holding decisions. Hence one would expect that managerial ownership is correlated to lagged firm performance. Managerial ownership might correlate to firm performance only because both of them are affected by historical firm performance. Dynamic panel models can help us distinguish this artificial relation from real effects. Secondly, the behavior of time dependency of firm performance is explored. The firm performance will be positively correlated to its previous performance, if a momentum effect exists. On the other hand, behavioral finance theories suggest that the firm's Tobin's Q would be negatively related to its lagged value, because the firm was view to be mis-valued previously and is corrected this period. Which effect dominates could be answered by the results of dynamic panel model.

[13] Please see Arellano and Bond (1991) for more detailed descriptions of these tests.

2.4 Data

2.4.1 Data Sources

The data used in this chapter are data of all firms in the S&P 500, the Midcap 400, and the Smallcap 600 available in Compustat and ExecuComp. The main variable of interest is managerial ownership, which is extracted from ExecuComp. Other company basic financial data are collected from Compustat, and are combined with the managerial holding data using GVKEY as the unique identifier for companies. The ExecuComp database consists of data from 1992 to 2009, which limits the time range of the sample. Observations with missing data in sales, total assets, total liabilities, property, plant & equipment (PP&E), operating income, and market capitalization are excluded from the sample. There are relatively many observations with missing data in stock volatility, R&D expenditure, and advertising expenditure. In order to maintain the sample size, I set these variables to zero when they are missing, and add dummy variables accordingly to indicate whether the original data is available.

Compared to the study by Himmelberg, Hubbard, and Palia (1999), my sample has two main advantages. Firstly, my sample size is substantially larger. My sample consists of 2948 firms and 29133 observations, while that of Himmelberg, Hubbard, and Palia (1999) consists of 398 firms and 2628 observations. Secondly, Himmelberg, Hubbard, and Palia (1999) select 600 firms which have no missing data in the year from 1982 to 1984. One can not reject that certain selection bias is introduced during this process, since the randomness of samples is limited. I include all the available data in this study. Problems like measurement errors and survivor bias might still exist, but randomness of samples is retained since no “hand-pick” procedure is taken during data collection process.

2.4.2 Proxy Variables

As discussed in previous sections, firms' observable characteristics as well as unobservable characteristics are assumed to be affecting firm performance and managers' contracting decisions. Unobservable characteristics are not measurable, but not negligible either, therefore I summarize them into the individual fixed effect term. For firm observable characteristics, it is important to find proper proxies to measure them.

Firm Performance

Tobin's Q is a widely used proxy for firm performance in empirical works. It measures how much higher the market value of equity is compared to the book value of equity. Not only as a performance measure, but it can also be used as a valuation measure and a growth measure. It also reflects investment opportunities that have been acquired or developed. In that sense Tobin'Q is connected to the firm's growth potential. Himmelberg, Hubbard, and Palia (1999) calculate the Tobin's Q, defined as the ratio of the value of the firm divided by the replacement value of assets. In this study I will stick to their calculation of Tobin's Q and use it as the proxy for firm performance. For firm value, I use the market value of common equity plus the estimated market value of preferred stock (roughly estimated as ten times the preferred dividend) plus the book value of total liabilities. For replacement value of assets, the book value of total assets is used.

$$Q = \frac{\text{MV of Common Equity} + \text{Preferred Stock Dividends} \times 10 + \text{BV of Total Liabilities}}{\text{BV of Total Assets}}$$

Managerial Ownership

Proxy for managerial ownership is straightforward. I use the percentage of firm's total common equity outstanding held by all top managers to measure managerial ownership.

Firm Size

One of the firm observable characteristics of great importance is firm size. The effect of firm size on firm performance is ambiguous. On one hand, the monitoring cost of large firm may be high due to bureaucracy and inefficient communication, indicating that larger firms have higher agency costs. On the other hand, the operating costs and production costs of large firm may also be lower because of scale of economy, which implies that larger firms higher better financial performance. Hence, the effect of firm size on financial performance is unclear. Here I use the logarithm of sales, LN(S), as the proxy for firm size. The square of log sales, $LN(S)^2$, is also added in the model, to allow for nonlinearity.

Monitoring Power

As previously discussed, the quality of a firm's corporate governance and hence the monitoring power of the board has a significant influence on the agency costs of firms. A firm with better corporate governance system can monitor executives' action with lower cost and hence have less agency costs. Otherwise, when the firm's corporate governance is loose and difficult to monitor top executives' decision process, the firm will probably offer more equity incentives to align the executives' personal interest to that of the other shareholders. Unfortunately the costs of firms used to monitor their executives are not directly observable. To measure monitoring power, I used the importance of fixed capital as a proxy variable, because fixed capital is easy to monitor. If a firm has a large portion of fixed capital, it is difficult for the executives to entrench themselves or be extravagant at the cost of shareholders' wealth. A common practice is to use the ratio of property, plant, and equipment to sales, K/S, as a measure of the importance of fixed capital in the firm. Its squared term, $(K/S)^2$, is also included to allow for nonlinearity, if exists.

Risk of Firm's Equity

Another important determinant of firm performance and managerial ownership is the risk of firm's equity. Except for financial return of the equity, the other side of the tradeoff, the risk of the equity is also a concern of shareholders. Risk sharing is a mechanism widely used in modern business world. It is also likely that executives are managing their own portfolio. For example, when a firm's equity prices are more volatile, its executives probably hold less firm shares. The volatility of stock price is used as a proxy of equity risk and is included in the analyses. There are relatively many observations with missing data in stock volatility, I set the missing volatility to zero and add dummy variables accordingly to indicate whether the original data is available, in order to maintain sample size.

Free Cash Flow

The ratio of operating income to sales is included as a proxy for market power of firms' free cash flows, which is defined as the cash flow left after profitable projects are invested. It measures the gross cash flows available from operations. Jensen (1986) argues that when a firm has sufficient free cash flows, the manager may use the cash to invest in non-profitable projects, rather than paying out to shareholders as dividends. Therefore, he suggests that monitoring power and corporate governance quality is positively related to a firm's market power of free cash flows. Operating income to sales is used to measure the firms' free cash flows, and is included in the analyses to control for its possible effect on firm performance.

R&D Intensity

R&D intensity is an important factor for firm performance and managerial holdings for the following reasons. Firstly, R&D intensive firms are mainly high growth firms. For these firms, the focus is future payoffs of investment decisions rather than the costs of projects or operating efficiency. The potential upward effect on equity price is enormous, if the R&D results turn out to be positive for the firm's future. The executives of R&D intensive firms also realize the upward potential and hence tend to hold more firm shares. The proxy for R&D intensity is the ratio of R&D expenditure to fixed capitcal of the firms. I also set the missing values to zero and include a dummy variable indicating missing R&D expenditure for the same reason of maintaining sample size.

Growth Opportunities

Similar to R&D intensity, growth opportunities of the firms are expected to have positive effects on firm performance and managerial ownership, as growth opportunities are also forward looking. The ratio of capital expenditure to fixed capital, and the ratio of advertising expenditure to fixed capital are used to control for the firms growth opportunities in this chapter. There are relatively many observations with missing data in advertising expenditure. In order to maintain sample size, I also set the variable to zero when missing, and add a dummy variable to indicate whether the original data is available.

Variable descriptions are summarized in Table 2.1.

TABLE 2.1 Variable descriptions

Variable	Description
Q	Tobin's Q, defined as the ratio of the value of the firm divided by the replacement value of assets. For firm value, I use the market value of common equity plus the estimated market value of preferred stock (roughly estimated as ten times the preferred dividend) plus the book value of total liabilities, and for replacement value of assets I use the book value of total assets. This definition is closely related to the market-to-book ratio, which is easily seen by subtracting total liabilities from both the numerator and denominator
m	The total common equity holdings of top-level managers as a fraction of common equity outstanding
m^2	The square of m, included to allow for nonlinearities
m1	Equals m if 0.00<m<0.05; 0.05 if m≥0.05
m2	Equals m-0.05 if 0.05<m<0.25; 0.00 if m>0.05; 0.20 if m≥0.25
m3	Equals m-0.25 if 0.25<m<1.00; 0.00 if m≤0.25
e	The average common equity holdings per manager. This number is calculated as the fraction of common equity held by top all managers divided by the number of top managers
LN(S)	The natural log of sales, used to measure firm size
$(LN(S))^2$	The square of LN(S), included to allow for nonlinearities in LN(S)
K/S	The ratio of tangible, long-term assets (property, plant, and equipment) to sales, used to measure the alleviation of agency problems due to the fact that such assets are easily monitored and provide good collateral
$(K/S)^2$	The square of K/S, included to allow for nonlinearities in K/S
Sigma	The standard deviation of idiosyncratic stock price risk, directly available in Compustat
Sig_dum	A dummy variable equal to unity if the data required to estimated SIGMA is available, and otherwise equal to zero (if SIGMA is missing). To maintain sample size and reduce the risk of sample selection bias, I set missing observations of SIGMA equal to zero, and then include this dummy variable to allow the intercept term to capture the mean of the SIGMA for missing values
Y/S	The ratio of operating income to sales, used to proxy for market power of cash flows and measure the gross cash flows available from operations
(R&D)/K	The ratio of research and development expenditures to the stock property, plant, and equipment, used to measure the role of 'R&D capital' relative to fixed capital
R&D_dum	A dummy variable equal to unity if R&D data were available, and otherwise equal to zero
A/K	The ratio of advertising expenditures to the stock of property, plant, and equipment, used to measure the role of 'advertising capital' relative to fixed capital
A_dum	A dummy variable equal to unity if advertissment data were available, otherwise zero
I/K	The ratio of capital expenditures to the stock of property, plant, and equipment

Source: Main part similar to Himmelberg et al (1999), and minor adjustments by the author.

2.4.3 Descriptive Statistics

The data used in this chapter is constructed of all firms in the S&P 500, the Midcap 400, and the Smallcap 600 in Compustat and ExecuComp, from 1992 to 2009. Observations with missing data in sales, total assets, total liabilities, property, plant & equipment (PP&E), operating income, and market capitalization are excluded from the sample. After refining the dataset, there are 29133 observations left for analysis. Table 2.2A provides an overview of the whole dataset. It shows that during 1992-2009, top managers as a group hold on average 3.7 percent of the total common equity of their firms. Scrutinizing the summary statistics for each year, I find that this measure lies relatively stable in the range of 3.2 percent to 4.4 percent. On average, each executive hold around 0.7 percent of their firms' total common equity.

TABLE 2.2A Descriptive statistics (overall)

Variable	N	Mean	Std. Dev.	1st Quartile	Median	3rd Quartile
Q	29133	2.079	2.222	1.158	1.518	2.256
m	29133	0.037	0.088	0	0.002	0.027
e	29133	0.007	0.018	0	0	0.005
LN(S)	29133	6.939	1.669	5.864	6.889	7.998
K/S	29133	0.485	2.426	0.111	0.208	0.436
Sigma	29133	8.984	19.016	0	0	0
Sig_dum	29133	0.225	0.417	0	0	0
Y/S	29133	0.003	6.102	0.089	0.151	0.247
(R&D)/K	29133	0.366	4.765	0	0	0.151
R&D_dum	29133	0.427	0.495	0	0	1
A/K	29133	0.097	0.522	0	0	0.023
A_dum	29133	0.292	0.455	0	0	1
I/K	29133	0.239	0.205	0.114	0.196	0.321

Source: Compiled by author.

Note: managerial holding variable m and e are reported in ratio, i.e. 0.038 means the top managers hold 3.8 percent of the firm's outstanding common equities.

The summary statistics of 2009 data are shown in Table 2.2B. The Tobin's Q is lower than its overall average, which shows the plunge of worldwide financial market due to subprime crisis. The managerial holding measures in this year, both aggregate measure and individual measure, are also substantially lower than the overall average. This can be interpreted in two ways. On one hand, top managers reduce their common equity holdings to avoid higher market risk during crisis time. On the other hand, firms also reduce executive compensation, including lowered stock payments. Either interpretation implies that managerial holdings are positively related with firm performance. More sophisticated analyses on this relationship are reported in the next section.

TABLE 2.2B Descriptive statistics (2009)

Variable	N	Mean	Std. Dev.	1st Quartile	Median	3rd Quartile
Q	1491	1.551	1.067	1.01	1.241	1.723
m	1491	0.027	0.076	0	0.002	0.014
e	1491	0.005	0.016	0	0	0.003
LN(S)	1491	7.539	1.606	6.463	7.453	8.578
K/S	1491	0.386	0.685	0.089	0.168	0.352
Sigma	1491	28.803	21.135	18.1	31	40.85
Sig_dum	1491	0.769	0.421	1	1	1
Y/S	1491	0.1	1.276	0.074	0.141	0.227
(R&D)/K	1491	0.473	2.232	0	0	0.193
R&D_dum	1491	0.435	0.496	0	0	1
A/K	1491	0.133	0.618	0	0	0.057
A_dum	1491	0.41	0.492	0	0	1
I/K	1491	0.237	0.176	0.126	0.206	0.312

Source: Compiled by author.

Note: managerial holding variable m and e are reported in ratio.

2.5 Effect of Managerial Ownership on Firm Performance

2.5.1 Determinants of Managerial Ownership

As previously discussed, managerial holdings are assumed to be endogenously determined in the contracting environment. Certain factors are unobservable but important in top managers' holding decisions. These factors such as monitoring power of shareholders, intangible assets, and market power are summarized in a fixed effect term and should be properly controlled for. The detailed identification strategies are discussed in model specification section. The estimation results of the determinants of total ownership of top managers without controlling any unobservable effect, those of controlling the industry fixed effect, and those of controlling the firm fixed effect are shown in Table 2.3A. Year dummies are included in each regression but not reported, as no noteworthy result is shown. The standard errors reported in brackets are robust to heteroskedasticity.

The second column reports the results of a simple pooled OLS, i.e., no unobservable industry or firm characteristics is controlled. Firm size is found to be negatively related to managerial ownership. A concave relationship between intensity of fixed capital (K/S as the proxy variable) and total managerial holdings is found. Firm's free cash flow shows a negative effect on managerial ownership. The stock volatility appears to have a negative effect on managerial holding, which confirms the assumption that top managers are risk averse. Growth opportunities (I/K as the proxy variable) have a positive effect on managerial holding. The other variables are statistically insignificant. The third column provides the results of the specification including the industrial fixed effects, which controls the unobserved heterogeneity at the industry level. Compared to the results of pooled OLS, only the negative effects of stock volatility and firm size and the positive effect of growth opportunities remain, with minor changes in scale.

The fourth column provides the results of the specification including the firm fixed effects. The negative relationship is confirmed between of firm size and managerial holding. Stock volatility remains significant and with similar scale to that from pooled OLS. The effect of R&D expenditure becomes positive and statistically significant. In general, the estimation results after controlling for firm's unobservable characteristics substantially differ from those of pooled OLS.

To more formally test the effect of unobservable individual fixed characteristics, I also carry out an F-test for the joint significance of individual fixed effect and a Hausman test for misspecifications. The null hypothesis of F-test is that the fixed effects for all groups are all zero. This is interpreted in this context as the unobservable characteristics have no impact on managerial ownership. When the null hypothesis is rejected, we can argue that individual fixed effect do affect managerial ownership. Hausman specification test requires the model being estimated twice, by within estimator and GLS estimator respectively, and then the error term structures of these two estimators are compared. Intuitively speaking, if the assumption of Hausman test holds, rejection of the null hypothesis indicates that the firm fixed effects, or the unobserved heterogeneities, are correlated with the other regressors. Test results reported clearly reject the assumptions that firm fixed effect is not affecting managerial ownership or firm fixed effect is uncorrelated with firms' other observable characteristics. Therefore, neglecting this individual effect will lead to the classic omitted variable problem, and is therefore biased.

The fifth and sixth columns report the results of specification with firm fixed effects, using two subsamples. The sample is split according to whether the firm is ranked in Fortune 500. The results of using non-Fortune 500 sample are similar to those using the whole sample, mainly due to the fact that non-Fortune 500 firms construct the major part of the whole sample. Most of the results using Fortune 500 firms are not statistically significant, except for the negative effect of stock volatility on managerial ownership. The different estimation results between these two samples show, to some extent, different holding decisions between top executives of Fortune 500 firms and those of non - Fortune 500 firms. In general, the results confirm the assumption that managerial ownership is not exogenous. The determinants of total managerial ownership contain both observable and unobservable firm characteristics.

Table 2.3B provides the estimation results of determinants of average managerial ownership. The independent variable is now ln(e + 0.00001), where e is the average managerial holding, i.e. total managerial ownership of a firm divided by the number of top managers in that firm. In general, the results of Table 2.3B show a similar pattern of those of Table 2.3A. In the pooled OLS, firm size, free cash flow, and stock volatility are negatively related to the firm's average managerial holding. The positive effect of capital expenditure to fixed capital ratio on average managerial holding also remains. A concave relationship between the fixed capital of the firm and managerial ownership is found.

Only firm size, stock volatility and growth opportunities are significant in the regression with the industry fixed effects controlled (the third column). After controlling for the firm's fixed effects (the fourth column), the negative effect of the firm size stays. The negative effect of stock volatility confirms that top managers are risk averse. The positive effect of R&D expenditure become significant and shows that top executives focus on growth opportunities of the firms when making their holding decisions. Test results also confirm the finding that the firm's unobserved characteristics are not negligible.

To summarize, I find that managerial ownership is negatively related to firm size and stock volatility, and positively related to R&D intensity and growth opportunities. The negative effect of firm size on managerial holding is because for similar value of stock ownerships, it is translated to smaller percentage amount in larger firms. The negative relationship between managerial holdings and stock volatility shows that the executives are risk averse. Moreover, the positive effects of R&D intensity and growth opportunities show that executives are also forward looking and would like to share the upward potential with the firms. Also, test results indicate that firm unobservable characteristics have certain impact on managerial ownerships. Among all the findings, the most important information inferred from Table 2.3A and Table 2.3B is that managerial ownership is not exogenous, but correlated with firms' observable characteristics as well as unobservable heterogeneity. Falsely assuming exogeneity for managerial ownership would introduce bias in estimates and lead to misleading conclusions. This evidence justifies the motivation of using panel specifications to analyze the effect of managerial holding on firm performance in the following sections.

TABLE 2.3A Determinants of total equity ownership by top managers

Variable	All firms (Pooled)	All firms (SIC3 effects)	All firms (Firm effects)	Fortune 500 (Firm effects)	Non 500 (Firm effects)
LN(S)	-0.026 (0.111)	0.038 (0.213)	0.329 (0.222)	-0.640 (1.125)	0.172 (0.278)
LN(S)^2	-0.075*** (0.007)	-0.085*** (0.015)	-0.051*** (0.018)	0.002 (0.062)	-0.034 (0.025)
K/S	-0.675*** (0.095)	-0.085 (0.054)	-0.005 (0.058)	-0.722 (0.765)	0.002 (0.058)
(K/S)^2	0.002*** (0.000)	0.000 (0.000)	0.000 (0.000)	0.066 (0.210)	0.000 (0.000)
Sigma	-0.008*** (0.003)	-0.010*** (0.004)	-0.008** (0.004)	-0.020* (0.012)	-0.006 (0.004)
Sig_dum	0.355** (0.178)	0.373 (0.235)	0.360* (0.214)	0.878* (0.465)	0.190 (0.252)
Y/S	-0.095*** (0.035)	-0.001 (0.013)	-0.001 (0.013)	-0.124 (0.499)	0.004 (0.013)
(R&D)/K	-0.010 (0.013)	-0.001 (0.007)	0.005*** (0.001)	-0.313 (0.480)	0.005*** (0.001)
R&D_dum	-1.102*** (0.064)	-0.940*** (0.275)	0.053 (0.280)	0.558 (0.513)	0.175 (0.314)
A/K	-0.035 (0.053)	-0.092 (0.088)	-0.060 (0.140)	0.111 (0.427)	-0.054 (0.136)
A_dum	0.767*** (0.068)	-0.023 (0.165)	-0.006 (0.140)	0.033 (0.269)	-0.078 (0.164)
I/K	2.305*** (0.299)	0.799** (0.407)	0.344 (0.214)	0.485 (0.624)	0.392* (0.207)
R^2	0.15	0.13	0.11	0.04	0.03
p-value (F-test)	-	0.00	0.00	0.00	0.00
Hausman	--	74.28	231.29	69.33	151.94
p-value (Hausman)	--	0.00	0.00	0.00	0.00

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, ***

indicate statistically significance at the 10% level, 5%level, and 1% level respectively.
"p-values (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.
"Hausman" and "p-values (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.
R^2 reports the adjusted R^2 value in the column of OLS, and overall R^2 value in the columns of within estimators.

TABLE 2.3B Determinants of average equity ownership per manager

Variable	All firms (Pooled)	All firms (SIC3 effects)	All firms (Firm effects)	Fortune 500 (Firm effects)	Non 500 (Firm effects)
LN(S)	-0.113 (0.093)	-0.070 (0.173)	0.134 (0.185)	-0.555 (0.903)	0.012 (0.232)
LN(S)^2	-0.056*** (0.006)	-0.064*** (0.012)	-0.034** (0.015)	0.003 (0.050)	-0.020 (0.021)
K/S	-0.565*** (0.079)	-0.074 (0.045)	-0.014 (0.049)	-0.633 (0.630)	-0.007 (0.048)
(K/S)^2	0.002*** (0.000)	0.000 (0.000)	0.000 (0.000)	0.060 (0.171)	0.000 (0.000)
Sigma	-0.007*** (0.003)	-0.009*** (0.003)	-0.007** (0.003)	-0.016* (0.009)	-0.005 (0.003)
Sig_dum	0.240 (0.149)	0.263 (0.196)	0.283 (0.178)	0.720* (0.377)	0.134 (0.210)
Y/S	-0.077*** (0.029)	0.002 (0.012)	0.000 (0.011)	0.020 (0.412)	0.004 (0.011)
(R&D)/K	-0.008 (0.011)	-0.001 (0.006)	0.004*** (0.001)	-0.224 (0.377)	0.004*** (0.001)
R&D_dum	-0.969*** (0.053)	-0.812*** (0.232)	0.041 (0.234)	0.453 (0.423)	0.143 (0.263)
A/K	-0.018 (0.045)	-0.067 (0.076)	-0.049 (0.115)	0.093 (0.352)	-0.044 (0.112)
A_dum	0.632*** (0.056)	-0.024 (0.139)	-0.006 (0.116)	0.023 (0.220)	-0.065 (0.136)
I/K	1.901*** (0.248)	0.668* (0.343)	0.292 (0.179)	0.398 (0.516)	0.331* (0.172)
R^2	0.16	0.13	0.11	0.04	0.03
p-value (F-test)	--	0.00	0.00	0.00	0.00
Hausman	--	90.89	129.32	43.31	177.19
p-value (Hausman)	--	0.00	0.00	0.03	0.00

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, ***

indicate statistically significance at the 10% level, 5%level, and 1% level respectively.
"p-values (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.
"Hausman" and "p-values (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.
R^2 reports the adjusted R^2 value in the column of OLS, and overall R^2 value in the columns of within estimators.

2.5.2 Effect of Managerial Ownership on Firm Performance (Static Panel Settings)

This subsection examines the empirical evidence of the effects of managerial ownership on firm performance. The functional forms of relationship are assumed to be in two specifications, quadratic form and locally linear form. In each specification, the identification schemes include pooled OLS, within estimator with industry fixed effects, and within estimator with firm fixed effects. I report the results of regressions with only the managerial ownership variables, the results of the regressions with the managerial ownership variables and all firm observable characteristics variables used in last section. The regression results of all regressors except the proxies for scope of discretionary spending (R&D/K, R&D_dum, A/K, A_dum and I/K) are also reported. The reported standard errors are robust to heteroskedasticity. Intercept terms and year dummies are included in all regressions, but not reported.

Table 2.4A provides the results of estimators with quadratic specifications of managerial holdings. For the results of pooled OLS estimates (Column 2), managerial ownership is positively related to firm performance, where the effect of its square term is negative. These results suggest an inverted U-shaped relation between managerial holding and firm performance. The pattern of this result does not remain significant when other firm characteristics variables are included in the regressions (Column 5 and Column 8). In those cases, only the positive linear relationship between managerial holdings and firm performance remains statistically significant.

The inverted U-shaped relation remains statistically significant after the industry fixed effect and the firm fixed effect are controlled. This inverted U-shaped effect is robust to inclusion of other firm characteristics, though the scales differ in small amounts. The estimations also suggest non-linear relationship exist between firm performance and firm size, and between firm performance and fixed capital to sales ratio. With regard to our main question of interest, the estimated results controlling for firm fix effect imply an optimal managerial holding of about 1.3 percent[14]. In other words, it is optimal for the firm to contract the top managers to hold about 1.3 percent of the firm's total equity.

To avoid model misspecification and to justify the usage of within estimators, the exogeneity of managerial ownership is again tested in the six specifications with individual fixed effects. The test is a Hausman model specification test which examines the relationship between independent variables and the firms' unobserved heterogeneity. The reported p-values of the tests show that, there exists almost no probability that the managerial ownership variable and other firm characteristics are uncorrelated with unobservable heterogeneities, in all specifications with individual fixed effects controlled. The test results confirm that managerial holding are correlated with firms unobserved characteristics, and hence the pooled OLS estimates suffer from endogenous bias. I also perform a Wald test to test for the joint significance of managerial ownership variables in each regression. The joint effect of managerial ownership and its squared term is statistically different from zero.

As discussed before, firm performance is suspected to be autoregressive. If this conjecture is true, then the error terms in static panel specification would show an autoregressive pattern. To formally test this assumption, I estimate and retain all the residuals in these specifications and carry out a test for serial correlation in residuals of panel data models, proposed by Wooldridge[15]. The null hypothesis of this test is that the panel data is not serial correlated. The results shown clearly reject the hypothesis of no serial correlation in residuals of static panel model. This finding justifies my later analyses of including the lagged performance in the models.

To summarize, Table 2.4A provides evidence that there exists an inverted U-shaped relation between managerial ownership and firm performance. This relationship is

[14] The estimation result in column 7 is used here.
[15] See Wooldridge (2002), pp. 282-283 for more details.

robust to the inclusion of firms' observable and unobservable characteristics. Also, the results from Hausman tests suggest that firm unobservable heterogeneity is correlated with managerial holdings and firms' other observable variables.

In an attempt to locate possible inter-temporal relationship, the same sets of regressions are carried out using managerial holding variables of last period, and the changes of managerial holding variables instead of simple managerial holding variables in level as regressors. The results are shown in Table 2.4B (using lagged managerial holding variables) and Table 2.4C (using managerial holding variables in first difference). Both Table 2.4B and Table 2.4C will be found in Appendix. Figures in Table 2.4B indicate positive linear relationship between managerial holding of last period and current firm performance. This intuitive finding supports the theory that managers can be better incentivized by holding more firms' equity. The non-linearity between lag managerial holding and firm performance is only significant when industry and firm unobservable characteristics are neglected. Since the Hausman tests confirm the validity and necessity of controlling for industry fixed effect and firm fixed effect, the positive effect of squared lag managerial holding and firm performance located in pooled OLS regressions can be ignored. In general, the more shares the top managers are holding, the better the firm's short-term future performance.

Figures in Table 2.4C propose a U-shaped relation between changes in managerial holding and firm performance. There exists a "lowest point" of 0.8 percent[16] change in managerial variables. More specifically, increasing 0.8 percent of managerial holding is weakest in terms of inducing good performance. These strange findings suggest that in order to increase next period's performance, firm should either increase managerial ownership by a large amount (to incentivize top executives) or decrease managerial ownership (even to replace existing managers in the extreme case).

[16] Estimation results from column 7.

Table 2.5A reports the results of the spline specification estimates. For pooled OLS, the first part of m, m1, is only statistically significant if no other variables are included. When other firm observable characteristics are included, only the second part of m, m2, is significant. The effect of large block of managerial holding, m3, on firm performance is not robust and vague. The pattern of these results remains similar after the industry fixed effect is controlled. The Hausman tests for misspecification are carried out and the results reject the exogeneity assumption of managerial ownership variables. Therefore the focus should be on the estimation results when industry or firm fixed effects are controlled. When the firm fixed effect is controlled and no other firm characteristics are included, both the first part and the second part of m are significant. Both coefficients are positive, indicating the managerial ownership is increasing in both regions, but at a lower rate when managerial ownership is larger (the coefficient of m2 is smaller than that of m1). These positive effects are not robust to inclusion of other firm observable characteristics, though the Wald test results support the joint significance of managerial holding variables. In general, a positive relation between managerial ownership and firm performance is located, when the scale of ownership is small. But this pattern of finding differs across model specifications and is statistically weak.

Estimations of using lagged managerial variables and differenced managerial variables as regressors are also reported in Table 2.5B and Table 2.5C respectively, which are located in Appendix. Results reported in Table 2.5B show a positive linear relationship between managerial holdings from last period and current firm performance, when managerial holdings from last period are in the region between 5% and 25%. This finding is consistent with the finding using quadratic specifications (results in Table 2.4B) that lagged managerial ownership is positively correlated with firms' current performance. This result can be interpreted as higher managerial ownership could incentivize the executives to work harder and make better decisions, and enhances firm performance for the next year. However, it is also likely that executives possess some information advantages of firm performance of the coming period, and adjust their holdings this period accordingly.

One noteworthy result in Table 2.5C is that the change of large managerial holding (m3 in the model) has a negative effect on firm performance. Intuitively, when the top executives are holding a large amount firm's shares, more than 25% in this context, decreasing their holdings will have substantially increase firm performance. This evidence is consistent with the inverted U-shape relationship between managerial holding and firm performance located in the quadratic specifications above. The rest of the results are again weak and unstable. These findings show that spline specification may not be a suitable functional form for the relation interested in this study. More formally, I also report the AIC and BIC of these models, the results also indicate that quadratic specifications are preferred over spline specifications. Therefore, in later part of the study, only quadratic form specification is examined.

TABLE 2.4A Determinants of firm value (Tobin's Q), quadratic specification, managerial holding variables in level

Variable	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects
m	2.217***	1.781***	2.596***	1.215***	1.432***	1.902**	1.326***	1.410***	2.018**
	(0.297)	(0.510)	(0.924)	(0.279)	(0.503)	(0.822)	(0.290)	(0.499)	(0.840)
m^2	-0.662***	-0.539***	-0.892***	-0.235	-0.418**	-0.713***	-0.134	-0.315*	-0.714***
	(0.177)	(0.171)	(0.174)	(0.206)	(0.194)	(0.153)	(0.175)	(0.173)	(0.154)
LN(S)	--	--	--	-1.027***	-0.845***	-1.211***	-1.422***	-0.998***	-1.273***
				(0.101)	(0.179)	(0.270)	(0.105)	(0.204)	(0.276)
$LN(S)^2$	--	--	--	0.062***	0.055***	0.062***	0.084***	0.063***	0.067***
				(0.007)	(0.012)	(0.017)	(0.007)	(0.013)	(0.018)
K/S	--	--	--	-0.057**	-0.055***	-0.108***	-0.201***	-0.079***	-0.098**
				(0.023)	(0.018)	(0.042)	(0.026)	(0.021)	(0.044)
$(K/S)^2$	--	--	--	0.000***	0.000***	0.000*	0.001***	0.001***	0.000*
				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SIGMA	--	--	--	-0.007***	-0.007**	-0.006**	-0.001	-0.006*	-0.007**
				(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
SIGDUM	--	--	--	0.351***	0.271**	0.171	0.206***	0.276**	0.195*
				(0.071)	(0.129)	(0.105)	(0.071)	(0.135)	(0.109)
Y/S	--	--	--	0.019***	0.016***	0.002	0.011	0.020***	0.011
				(0.006)	(0.005)	(0.011)	(0.010)	(0.006)	(0.011)

(R&D)/K	--	--	--	-0.004 (0.003)	-0.008*** (0.001)	-0.004*** (0.001)	--	--	--
RDUM	--	--	--	0.521*** (0.026)	0.443*** (0.114)	0.011 (0.083)	--	--	--
A/K	--	--	--	0.102*** (0.039)	0.106 (0.077)	0.287** (0.122)	--	--	--
ADUM	--	--	--	0.244*** (0.032)	0.142** (0.068)	-0.221*** (0.075)	--	--	--
I/K	--	--	--	2.409*** (0.298)	2.099*** (0.523)	1.714*** (0.360)	--	--	--
R^2	0.02	0.02	0.02	0.16	0.15	0.12	0.09	0.08	0.08
p-value (F-test)	--	0.00	0.00	--	0.00	0.00	--	0.00	0.00
Hausman	--	264.82	129.02	--	54.72	296.23	--	51.44	92.17
p-value (Hausman)	--	0.00	0.00	--	0.00	0.00	--	0.00	0.00
Wald	31.86	6.56	13.27	9.53	4.35	10.89	10.45	4.26	10.87
p-value (Wald)	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00

p-value (serial corr.)	--	--	0.00	--	--	0.00	--	--	0.00
AIC	128556	123603	113819	124239	121926	112594	126566	122985	113214
BIC	128722	123760	113976	124504	122182	112850	126790	123200	113429

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"p-value (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

"Wald" and "p-value (Wald-test)" are test statistics and their corresponding p-values of the Wald tests for joint significance of managerial holding variables.

"p-value (serial corr.)" reports the p-values of Wooldridge's test for serial correlation in the errors terms of panel models. e.g., a p-value of 0 rejects the null hypothesis that there is no first order autocorrelation in the error terms.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

R^2 reports the adjusted R^2 value in the column of OLS, and overall R^2 value in the columns of within estimators.

TABLE 2.5A Determinants of firm value (Tobin's Q), spline specification, managerial holding variables in level

Variable	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects
m1	7.179***	2.946*	3.555*	-0.076	0.542	3.236*	0.871	0.833	3.137
	(0.987)	(1.629)	(1.929)	(0.977)	(1.494)	(1.869)	(0.958)	(1.571)	(1.914)
m2	0.548	1.176*	1.968**	1.283***	1.377*	1.137	1.222***	1.316**	1.353*
	(0.432)	(0.664)	(0.893)	(0.410)	(0.687)	(0.804)	(0.416)	(0.663)	(0.817)
m3	1.233	0.937	0.906	0.889	0.790	0.779	1.064	0.868	0.790
	(1.040)	(0.797)	(1.842)	(1.010)	(0.731)	(1.775)	(1.011)	(0.876)	(1.780)
LN(S)	--	--	--	-1.029***	-0.847***	-1.217***	-1.423***	-0.999***	-1.277***
				(0.101)	(0.179)	(0.271)	(0.105)	(0.204)	(0.277)
$LN(S)^2$	--	--	--	0.062***	0.055***	0.063***	0.084***	0.063***	0.067***
				(0.007)	(0.012)	(0.017)	(0.007)	(0.013)	(0.018)
K/S	--	--	--	-0.059***	-0.055***	-0.108**	-0.202***	-0.079***	-0.098**
				(0.023)	(0.018)	(0.042)	(0.026)	(0.021)	(0.044)
$(K/S)^2$	--	--	--	0.000***	0.000***	0.000*	0.001***	0.001***	0.000*
				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SIGMA	--	--	--	-0.007***	-0.007**	-0.006**	-0.001	-0.006*	-0.007**
				(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
SIGDUM	--	--	--	0.352***	0.272**	0.175*	0.207***	0.277**	0.199*
				(0.071)	(0.129)	(0.105)	(0.071)	(0.135)	(0.109)

Y/S	--	--	--	0.019*** (0.006)	0.016*** (0.005)	0.002 (0.011)	0.011 (0.010)	0.020*** (0.006)	0.011 (0.011)
(R&D)/K	--	--	--	-0.004 (0.003)	-0.008*** (0.001)	-0.004*** (0.001)	--	--	--
RDUM	--	--	--	0.516*** (0.026)	0.440*** (0.112)	0.008 (0.083)	--	--	--
A/K	--	--	--	0.102*** (0.039)	0.106 (0.077)	0.289** (0.121)	--	--	--
ADUM	--	--	--	0.246*** (0.032)	0.141** (0.068)	-0.222*** (0.075)	--	--	--
I/K	--	--	--	2.416*** (0.301)	2.099*** (0.524)	1.714*** (0.361)	--	--	--
R^2	0.02	0.02	0.02	0.16	0.15	0.12	0.09	0.08	0.08
p-value (F-test)	--	0.00	0.00	--	0.00	0.00	--	0.00	0.00
Hausman	--	3253.28	174.84	--	69.39	302.79	--	45.65	217.90
p-value (Hausman)	--	0.00	0.00	--	0.00	0.00	--	0.00	0.00
Wald	39.31	5.17	5.15	9.02	3.33	3.74	10.52	3.36	4.03

p-value (Wald)	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.02	0.01
p-value (serial corr.)	--	--	0.00	--	--	0.00	--	--	0.00
AIC	128528	123609	113833	124242	121932	112603	126572	122990	113224
BIC	128702	123774	113999	124516	122197	112868	126804	123214	113447

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

“p-value (F-test)” reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.

“Hausman” and “p-value (Hausman)” report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

“Wald” and “p-value (Wald-test)” are test statistics and their corresponding p-values of the Wald tests for joint significance of managerial holding variables.

“p-value (serial corr.)” reports the p-values of Wooldridge’s test for serial correlation in the errors terms of panel models. e.g., a p-value of 0 rejects the null hypothesis that there is no first order autocorrelation in the error terms.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

R^2 reports the adjusted R^2 value in the column of OLS, and overall R^2 value in the columns of within estimators.

2.5.3 Effect of Managerial Ownership on Firm Performance (IV Specifications)

This section discusses the relationship between managerial holding and firm performance identified using instrumental variable regression strategy. The main difficulty in the application of this identification strategy is the choice of instruments. A valid instrument should be uncorrelated with the explained variable and correlated with the instrumented variables. A strong instrument should be highly correlated with the instrumented variables. Empirical evidence from Table 2.3A and Table 2.3B show that firm size and stock price volatility are correlated with managerial holding. Himmelberg, Hubbard, and Palia (1999) also use firm size and stock volatility as instruments. Therefore I choose LN(S), $LN(S)^2$, SIGMA, and SIGDUM as the instrumental variables. The quadratic specification for managerial ownership is used to reduce the number of instruments required for identification. The empirical results are shown in Table 2.6.

The second column reports the results of pooled OLS. The inverted U-shaped relation between managerial ownership and firm performance located previously is confirmed in this instrumental variable setting, but statistically not significant. The third column reports the results when the industry fixed effect is controlled. The inverted U-shaped relationship is statistically significant. When the fixed effect on firm level is controlled, the inverted-U shape remains to be significant as shown in the fourth column of Table 2.6. The Wald test result also indicates that the managerial ownership variables are statistically significantly different from zero. However, the test results for over-identification reject the validity of instruments. The results of Table 2.6 are only used to show that previous researches using these instruments should be reviewed with caution.

TABLE 2.6 Ownership-performance model with instrumental variables

Variable	Pooled	SIC3 effects	Firm effects
m	61.849 (46.082)	38.010*** (12.347)	71.773*** (7.940)
m^2	-215.077 (175.354)	-137.691** (55.783)	-47.736*** (14.950)
K/S	0.050 (0.032)	-0.028 (0.070)	-0.066* (0.035)
$(K/S)^2$	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Y/S	-0.001 (0.007)	-0.007 (0.018)	-0.009 (0.009)
(R&D)/K	0.000 (0.007)	-0.005 (0.010)	-0.010** (0.005)
R&D_dum	0.714*** (0.102)	0.722*** (0.203)	0.145 (0.180)
A/K	0.146 (0.147)	0.068 (0.106)	0.268*** (0.088)
A_dum	0.569*** (0.183)	0.401** (0.180)	-0.331*** (0.088)
I/K	3.358*** (0.637)	2.798*** (0.400)	1.381*** (0.151)
Uncentered R^2	-15.92	-14.78	-2.36
p-value (F-test)	-	0.00	0.00
Wald	4.02	11.16	138.98
p-value (Wald-test)	0.13	0.00	0.00
Hansen/Sargan	46.23	14.82	21.78
p-Overid.	0.00	0.00	0.00

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, ***

indicate statistically significance at the 10% level, 5%level, and 1% level respectively.
p-value (F-test) are p-values of F-tests for fixed effects.
p-value (Wald-test) are p-values of Wald-tests for joint significance of m and m^2.
"Hansen/Sargan" report the Hansen test statistic for OLS, and Sargan test statistics for within estimator. The null hypothesis of these two tests are the orthogonality restrictions used are valid. "p-Overid." report the corresponding p-values.

2.5.4 Effect of Managerial Ownership on Firm Performance (Dynamic Panel Settings)

Now let's turn to dynamic panel settings. The residuals from static panel models are proved to be serial correlated by previous evidence. As discussed in model specification section, within estimator is not consistent anymore when the lagged dependent variable is also included as one of the explanatory variables. But since the within estimator and the OLS estimator are biased in opposite directions, it is still informative to run both of these knowingly inconsistent regressions, in order to have a "consistent range". I will also report the estimation results by difference GMM and system GMM estimators. The second lag and previous lags of variables are used as instruments. To avoid the case that the second lag is also correlated with the error term, I provide the results of using variables from the third lag and previous lags as instruments.

The second and the third column of Table 2.7A report the results of pooled OLS and the results of within estimator controlling for firm fixed effects, respectively. The firms' performance of last period has a positive effect on their current performance. This shows the momentum effect of firm performance, good firms tend to perform well, at least in the near future. With regard to the main question of interest, the managerial holding variables are not significant anymore after the lagged performance variable is included. I also use the Wald test to check the joint significance of the managerial holding variables. The results show that managerial ownership variables are jointly significant in pooled OLS setting but are not statistically significant after firm fixed effects are controlled.

The fourth and the fifth column report the estimation results using difference GMM. To avoid the case that the second lagged of firm performance is, to some extent, correlated with the differenced error terms, I also carried out the estimation using variables from the third lag and earlier lags as instruments. The results confirm the positive time dependency of firm performance. The managerial holding variables are still not significant. Moreover, the Wald tests fail to reject the null hypothesis that, both of these variables are statistically different from zero. Hence we can not claim a relation between firm performance and managerial holdings.

As mentioned in the model specification section, I also test the assumptions on error term distribution. If the error terms are independently distributed, which is a vital assumption for the consistency of difference GMM, then the differenced error terms follow an MA(1) process. The test results confirm this hypothesis (more precisely, the tests reject the null hypothesis that the differenced error terms do not follow an MA(1) process). The test results provide no evidence that the differenced error terms follow an MA(2) process. In summary, the error term behaves as assumed. The risk of over-fitting the endogenous variables should be recognized, since there are too many instruments used in these two specifications. Here I report the results of two J tests for over-identifying restrictions, Sargan test and Hansen test. Sargan test is robust to many instruments used, while Hansen test is robust to the distribution of error terms. The results of Sargan tests show that there are certain invalid restrictions used. But the results of Hansen tests could not reject the validity of the restriction conditions.

The results using system GMM are reported in column six and column seven. The results are similar to those using difference GMM. Lagged performance has a positive effect on current performance, while managerial ownership variables have no statistically significant effect. The Wald tests also reject the joint effect of managerial holding on firm performance. Similar to the evidence of difference GMM, the test results for error terms behavior support the application of system GMM. The contradicting results of Sargan test and Hansen test could not provide strong evidence to support the validity of restriction conditions used. To be cautious, I could not claim that the estimations using difference GMM and system GMM are precise and can be applied to predict future performance. However, together with the estimation using pooled OLS and within estimator, the rejection of the effect of managerial holding on firm performance is assured.

To put another effort to conquer the risk of over-fitting the endogenous variables, I do the same set of regressions with less explanatory variable. By including less regressors, the number of orthogonality conditions decreases substantially, as a result the problem of over-identifying conditions is alleviated. The results are reported in Table 2.7B. The results of pooled OLS and within estimator confirm the momentum effect on firm performance. The effect of managerial ownership on firm performance is not located, either individually or jointly. These results stay when difference GMM and system GMM are applied. The test results for residuals show that error term behaves as assumed. However, the test results for over-identifying restrictions indicate that some orthogonality conditions are invalid in these specifications.

To summarize the main evidence provided in Table 2.7A and Table 2.7B, no relation between firm performance and managerial holding can be located after the lagged performance is taken into account. Firm performance of last period has a strong positive predicting power on current firm performance. The spurious association between managerial ownership and firm performance found in static panel setting is possibly due to the fact that both variables are highly affected by an important omitted variable, lag performance.

TABLE 2.7A Determinants of firm value (Tobin's Q) including lagged performance, quadratic specification

Variable	Pooled OLS	Firm effects (Within)	Dif.- GMM (2 lags)	Dif.- GMM (3 lags)	Sys.- GMM (2 lags)	Sys.- GMM (3 lags)
lag Q	0.397***	0.195***	0.121***	0.231***	0.123**	0.339***
	(0.061)	(0.041)	(0.045)	(0.132)	(0.049)	(0.082)
m	0.209	0.449	17.030	3.524	-7.763	-4.923
	(0.243)	(0.479)	(19.962)	(22.945)	(22.433)	(18.188)
m^2	0.574	-0.308	-25.354	-2.695	83.029	38.110
	(0.425)	(0.894)	(42.855)	(54.177)	(65.310)	(45.031)
LN(S)	-0.581***	-0.717***	-3.134	-8.100**	-4.426***	-7.002
	(0.081)	(0.130)	(2.104)	(3.219)	(1.698)	(4.750)
$LN(S)^2$	0.036***	0.032***	-0.001	0.470**	0.430***	0.524
	(0.005)	(0.009)	(0.197)	(0.231)	(0.157)	(0.373)
K/S	-0.076***	-0.197***	-1.652	-0.881	-2.792**	0.425
	(0.017)	(0.066)	(1.043)	(0.803)	(1.356)	(1.158)
$(K/S)^2$	0.001***	0.001*	0.003	0.004	0.007	-0.003
	(0.000)	(0.001)	(0.005)	(0.004)	(0.006)	(0.006)
Sigma	-0.003**	-0.002	-0.010	-0.002	0.036	0.025
	(0.001)	(0.002)	(0.015)	(0.012)	(0.024)	(0.020)

Sig_dum	0.116**	0.015	0.813	0.804	-1.438	-0.967
	(0.051)	(0.084)	(1.215)	(1.103)	(1.724)	(1.396)
Y/S	0.011***	-0.007	-0.258	0.052	-0.397	0.142
	(0.004)	(0.009)	(0.248)	(0.223)	(0.345)	(0.308)
(R&D)/K	-0.002	-0.003***	-0.068	-0.069	-0.084	-0.053
	(0.002)	(0.001)	(0.081)	(0.072)	(0.095)	(0.053)
R&D_dum	0.267***	-0.063	-12.507*	-10.786	2.523	0.080
	(0.033)	(0.070)	(6.468)	(7.791)	(1.864)	(1.738)
A/K	0.059**	0.172*	2.155	2.953	4.402	3.027
	(0.030)	(0.097)	(1.696)	(1.821)	(3.266)	(2.678)
A_dum	0.100***	-0.152***	-4.118*	-3.174	-2.362	-3.008***
	(0.024)	(0.059)	(2.225)	(2.181)	(1.741)	(1.035)
I/K	0.965***	0.911***	1.344	2.539	5.708***	3.259
	(0.201)	(0.246)	(1.633)	(2.105)	(1.617)	(1.718)
Wald	9.32	1.01	0.83	0.08	2.58	1.28
p-Wald	0.00	0.36	0.66	0.96	0.28	0.53
p-Sargan	-	-	0.00	0.00	0.00	0.00

p-Hansen	-	-	0.74	0.22	0.76	0.15
p-MA(1)	-	-	0.00	0.00	0.00	0.00
p-MA(2)	-	-	0.93	0.88	0.70	0.93

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

‘‘Wald” and “p-wald” report the Wald statistic and the associated p-value for the joint significance of managerial holding variables, m and m^2.

“p-Sagan” and “p-Hansen” report the p-value of the Sagan test and Hansen for over-identifying restrictions.

“p-MA(1)” and “p-MA(2)” report the p-value of the tests for first order and second order serial correlation, respectively. “p-MA(1)” reports the probability of the test statistics show the differenced error terms follow an MA(1) process, when they are indeed not. “p-MA(2)” is interpreted analogously.

TABLE 2.7B Determinants of firm value (Tobin's Q) including lagged performance, quadratic specification

Variable	Pooled OLS	Firm effects (Within)	Dif.- GMM (2 lags)	Dif.- GMM (3 lags)	Sys.- GMM (2 lags)	Sys.- GMM (3 lags)
lag Q	0.432***	0.208***	0.139***	0.312***	0.208***	0.445***
	(0.061)	(0.041)	(0.043)	(0.101)	(0.057)	(0.049)
m	0.170	0.528	27.947	4.264	-16.643	-14.620
	(0.241)	(0.474)	(18.365)	(20.153)	(16.734)	(13.194)
m^2	0.604	-0.395	-30.826	12.452	62.428	42.742
	(0.430)	(0.888)	(39.627)	(50.992)	(40.836)	(27.581)
LN(S)	-0.709***	-0.729***	-3.536**	-8.834***	-3.906***	-4.902
	(0.089)	(0.132)	(1.780)	(2.994)	(1.514)	(3.708)
$LN(S)^2$	0.043***	0.033***	0.044	0.529***	0.305**	0.356
	(0.006)	(0.009)	(0.187)	(0.201)	(0.129)	(0.282)
K/S	-0.153***	-0.204***	-1.580*	-0.960	-4.909***	-0.144
	(0.022)	(0.067)	(0.930)	(0.744)	(1.813)	(0.801)
$(K/S)^2$	0.001***	0.001*	0.003	0.005	0.016**	-0.003
	(0.000)	(0.001)	(0.005)	(0.004)	(0.008)	(0.005)
Sigma	0.000	-0.002	-0.001	0.011	0.044**	0.008
	(0.001)	(0.002)	(0.015)	(0.012)	(0.022)	(0.015)

Sig_dum	0.047 (0.048)	0.021 (0.083)	-0.275 (1.048)	-0.303 (0.898)	-1.848 (1.740)	-0.389 (0.928)
Y/S	0.009 (0.006)	-0.006 (0.009)	-0.208 (0.216)	0.078 (0.201)	-0.760 (0.474)	-0.033 (0.207)
Wald	8.07	1.30	3.16	0.98	3.17	2.71
p-Wald	0.00	0.27	0.21	0.61	0.20	0.26
p-Sargan	-	-	0.00	0.00	0.00	0.00
p-Hansen	-	-	0.03	0.00	0.00	0.00
p-MA(1)	-	-	0.00	0.00	0.00	0.00
p-MA(2)	-	-	0.22	0.73	0.18	0.29

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

‘‘Wald” and “p-wald” report the Wald statistic and the associated p-value for the joint significance of managerial holding variables, m and m^2.

“p-Sagan” and “p-Hansen” report the p-value of the Sagan test and Hansen for over-identifying restrictions.

“p-MA(1)” and “p-MA(2)” report the p-value of the tests for first order and second order serial correlation, respectively. “p-MA(1)” reports the probability of the test statistics show the differenced error terms follow an MA(1) process, when they are indeed not. “p-MA(2)” is interpreted analogously.

2.6 Conclusions

Many empirical works focusing on analyzing the relationship between firm performance and managerial holding have been done. The main variable of interest, managerial ownership, is likely affected by the contracting environment, and hence not exogenous. Controlling for the firms' unobserved heterogeneity, I find that managerial ownership is negatively related to firm size and stock price volatility, but positively related to R&D intensities and growth opportunities. In addition, firm unobservable heterogeneity also has an impact to managerial ownerships. This evidence justifies the motivation of using panel specifications to control for the endogeneity of managerial ownership variables

When analyzing the relationship between firm performance and managerial holding, I report the results of pooled OLS, within estimators including industry fixed effects, and within estimators including firm fixed effects. The inverted U-shaped relation found in earlier studies are confirmed in pooled OLS. This relationship remains statistically significant after the industry fixed effect or the firm fixed effect is controlled. Empirical evidence does not strongly suggest a local linear form relationship in general, since the managerial ownership variables are seldom significant when using the spline specification.

To allow for the time dependence of firm performance, I extend the study to dynamic panel setting. It is assumed that the current firm performance has an impact on its performance in the near future and top managers holding decisions simultaneously. The serial correlated patterns of the regression residuals from static panel setting also justify the use of dynamic panel settings. When the lagged firm performance is included as one of the independent variable, no relationship between firm performance and managerial holding can be located. The results suggest that a strong momentum effect existing in firm performance, even when firm fixed effect is controlled. The effect of managerial ownership on firm performance is not statistically significant, and the joint effect of two managerial holding variables is also rejected. Hence, we can conclude that, managerial ownership has no impact on firm performance. The spurious inverted U-shaped relationship we find in static panel setting appears mainly because both variables are related to historical firm performance. Top executives will take the firm's recent financial performance into consideration when making contracting decisions, because it has strong predictive power on the firm's performance at least in the near future.

This evidence can be interpreted in two ways. One interpretation is that the optimal contracting hypothesis applies, and an inverted-U shape exists theoretically. In this case, only those lying near the top of the inverted-U shape are near the optimal managerial holding level. The executives lying on the left part of the inverted-U shape are under-incentivized (and should hold more firm shares), while those lying on the right part are over-incentivized (and should reduce their firm holdings). Firms realize this problem, and move toward the optimal incentive level by requiring the under-incentivized executives to hold more firm shares, and reducing the over-incentivized ones' share holdings. In equilibrium, all performance-managerial holding pairs locate near the optimal managerial holding level, and therefore no obvious pattern is shown in data. This equilibrium interpretation implies the optimal contracting hypothesis works well in the market. Another interpretation is all executives are managing their personal portfolios. As they are risk averse, they would strive to diversified their portfolios and be hedged from market risk. No relationship between managerial holding and firm performance implies that executives are successful in un-relating their personal wealth from firm performance and avoiding excessive risks in their private portfolios.

However, which interpretation is more appropriate could not be answered in this study. More sophisticated studies are needed to dig deeper in this question.

Chapter III:

Are Equity Incentives Effective in Enhancing Firm Performance?

3.1 Introduction

The principal-agent problem has been under extended studied since it was firstly raised by Berle and Means (1932). Jensen and Meckling (1976) define the severity of the principal-agent problem as the degree of interest mismatch between managers and shareholders, and suggest rewarding managers with firm shares to align interests and incentivize managers. In order to test whether equity incentives effectively lower agency costs as they were originally designed and used for, researchers focus on relating the use equity incentives and firm performance. Previous empirical works offer various evidence and no consensus has been reached.

In this study, I analyze the effect of stocks awards and stock options to executives on firm performance using static and dynamic panel settings. It is well recognized that the amounts of equity incentives and firm performance are jointly determined in the contracting environments. Important factors which are believed to be affecting both equity incentives and firm performance such as firm size, stock return volatility, R&D intensity, and firm- and personal unobservable characteristics, have been controlled for in existing studies. However, another important factor, firm performance from last period has long been ignored. A firm's current performance is likely to be affected by its past performance, while the use of stocks and options in executive compensation package is also likely to relate to past firm performance. Therefore, past performance has impacts on both equity incentives and current firm performance, and its effects should be appropriately accounted for. To my knowledge, existing studies fail to include firm performance dynamics in analyzing the effects of equity incentives on firm performance. In an attempt to fill in the blank, this study researches the effects of previous firm performance and equity incentives on firm performance using dynamic panel setting, by exploring all firms in the S&P 500, the Midcap 400, and the Smallcap 600 from 1992 to 2009. Unlike most of the existing studies aggregating the value of stock awards and option awards, I estimate the effects of these two kinds of equity incentives on firm performance separately.

To summarize the evidence provided using static panel specifications, I find that firm performance is increasing at decreasing rates with the option awards for executives from 1992-2009. Firm performance are found to be positively related to executives' option awards from last period from 1992 to 2005, and positively related to the changes of option awards from 2006 to 2009. No statistically significant relation is found between executives' stock awards and firm performance from 1992 to 2009. Both the amounts of executives' stock awards from last period and the changes of stock awards have positive effect on firm performance from 1992 to 2005. From 2006 on, the changes of executives' stock awards are positively related to firm performance, while the stock awards executives received from last period are negatively related to the firms' current performance. Moreover, firm's unobservable characteristics as well as individual unobservable characteristics are correlates with the executives' equity incentives and other firm observable factors, hence their effects should be properly accounted for.

When the firms' performance from last period is also included in the analyses, a positive time dependency in firm performance is found. An inverted U-shaped relation between the amounts of option awards and firm performance is also located from 1992 to 2005, with unrealistically large turning points. Therefore only the left parts of the inverse U shapes are relevant and the relations are effectively concave and positive. Intuitively, firm performance is increasing with executives' option awards at decreasing rates.

The contributions of this study are fourfold. Firstly, I provide empirical evidence under static panel settings with a large number of firms in a long period. The mixed evidence provided by current researches in relating equity incentives and firm performance are partly due to the fact that these researches are scrutinizing different samples. In an attempt to update the understandings in this question, I apply the commonly used static panel settings on a sample consisting of all firms in the S&P 500, the Midcap 400, and the Smallcap 600, from 1992 to 2009.

Secondly, I present the relationships between equity incentives and firm performance after controlling for past firm performance. It is likely that the previous identified relationship is spurious, simply because both firm performance and equity incentives are driven by a same omitted variable. Researchers try to catch the omitted variables by including various proxies, but firm performance from last period has always been ignored. Because both equity incentives and current firm performance are likely to be affected by past performance, I include it in the study and offer evidence after it is properly controlled for.

Thirdly, I decompose the effect of stock awards and option awards on firm performance. The common practices of analyzing the effect of equity incentives on firm performance are aggregating the value of stock awards and option awards and estimating the joint effect. But aggregating the two simply neglects the nature differences of stock awards and option awards, which is not convincing because the payoff structures of stocks and options to managers differ substantially. The differences in nature and payoff structure will likely lead to different effects on executive behaviors and hence different effects on firm performance. In this chapter, I estimate the effects of stock awards and option awards to firm performance separately.

Fourthly, I offer an example of applying difference GMM and system GMM in analyzing the relationship between managerial ownership and firm performance. Financial economists have been struggling to find valid instruments to control for endogeneity, since almost every variable is closely related to the others in the modern business environments. Those meticulously designed econometric methods such as difference GMM and system GMM may be productive alternatives to the dominant methods such as within estimator and instrumental variable regressions.

The rest of this chapter is organized the following. Section 3.2 reviews some important studies in this field. Section 3.3 discusses the functional form of the models and specification strategies, and the data used are introduced in Section 3.4. The empirical evidences are presented in Section 3.5. Section 3.6 concludes.

3.2 Literature Review

The principal-agent problem is a popular research topic in academic communities and business societies. Because manager's effort is unobservable and the cost of monitoring his action is high, a common proposal to mitigate principal-agent problem is to align the manager's interest with that of the principal's, by awarding manager with firm equity.

The use of stock options as part of CEO compensations increased significantly since 1980. Hall and Liebman (1998) document that only 30% of CEOs received stock options in their compensation contracts, and the average value of options were less than one fourth of the average value of salary and bonus, in 1980. By 1994, 70% of CEOs received stock options and the average value of options climbed up to the average value of salary and bonus. Similarly, using CEO compensation data from 1993 to 1998, Core, Guay and Verrecchia (2000) document that the value of stock options and restricted stocks contributed about one third of CEOs' total compensation package on average. Hall and Murphy (2002) report that in 1998, the value of stock options and restricted stocks held by S&P Industrial CEOs was $30 million, and that of S&P Financial CEOs was $55 million, on average. These values are significantly larger than the amount of salary and bonus in the CEOs' compensation.

In order to test whether equity incentives effectively lower agency costs as they were originally designed and used for, researchers focus on relating the use equity incentives and firm performance. Murphy (1985) applies the panel data setting and control for the firm fixed effect in estimating the relation between executive compensation and firm performance. He reports a strong positive relation between executive pay and firms' stock return. He also provides evidence that large firms tend to pay their executives more than smaller firms, but the return of larger firms are lower. Mehran (1995) studies the executive compensation structures of 153 firm using data from 1979-1980, and analyzes the relationship between executive compensation and firm performance. He finds a positive relation between managerial ownership and firm performance, using Tobin's Q and return on assets as proxies. In addition, the percentage of equity incentives in executive total compensation is also found to be positively related to firm performance. Interestingly, Mehran (1995) shows that managerial ownership for an executive is negatively related to the percentage of equity incentives in his compensation packages. Jensen and Murphy (1990) collect data of executive stock holdings data from 430 large companies' proxy statements in 1987, and show that CEO wealth changes $3.25 in response to $1000 change in shareholder wealth, i.e. the estimated pay-for-performance sensitivity to be 0.325%. They decompose the effect and show that only 0.075% wealth changes are arise from the sum of performance related compensation such as stock option grants and threat of dismissal. Hall and Liebman (1998) study a sample of large U.S. firms in 1994 and estimate that average CEO wealth increases $25.11 in response to a $1000 increase in shareholder wealth. The corresponding value change in stock options is $3.66. Both measures are significantly larger than Jensen and Murphy (1990)'s estimations, indicating that CEOs' wealth are more strongly related with firm performance. In Murphy's later survey (Murphy (1999)), he estimates the pay-for-performance sensitivity again using S&P 500 company data from 1996, and shows that the pay-for-performance sensitivity increased to about 0.6%. Regardless of the increase in pay-for-performance sensitivity, he still argues that both estimated magnitudes are too low to be consistent with principal-agent theory. Besides most of the researchers who reviewed U.S. firms, Conyon (1997) studies this problem using data from 213 large UK companies between 1988 and 1993. He reports that the compensations of firms' directors are positively related to firm performance, which is measured as shareholder returns. However, he finds that firms' stock returns from last period are not related to executive compensations of current period. He also provides evidence that corporate governance variables have influences on determining executive compensations.

Core and Guay (1999) develop a theoretical model to analyze the optimal equity compensation for CEOs, and argue that the optimal equity compensation depends on firm characteristics such as firm size, growth opportunities, and monitoring costs. Furthermore, since the optimal equity compensation levels may vary over time and the value of firm equity in executives' portfolio change over time, the alignment effect of the optimal equity compensation may become weaker as time passes. Another interesting and intuitive evidence they present is that the aggregate amounts of stocks and stock options in CEOs' portfolio are better measurement than only considering CEOs' stock ownership, as the explanatory power of equity incentive are substantially larger when using total stocks and options as proxy for equity incentives. Palia (2001) takes executive compensation as endogenously determined and shows that controlling for the firms' unobservable heterogeneity has an impact on the relation between firm performance and executive equity incentives. He reports an inverted U-shaped relationship between executive compensation and firm performance when applying OLS estimation, but this relationship is statistically insignificant when he applies the instrumental variable estimation, using CEO experience, CEO age, CEO education quality and firm volatility as instruments. Habib & Ljungqvist (2005) explicitly estimate the "theoretical optimal contracting level" and compare it with actual executive compensation in U.S. companies between 1992 and 1997. They find a positive relation between firm value and CEO stock holdings, and a negative relation between firm value and option holdings, i.e. firms are away from their optimal contracting levels by awarding their CEOs too little stocks and too many options.

A stream of studies argues that the alignment effect of equity incentives varies with firm risk and so is the optimal contracting level. Garen (1994) analyzes the determinants of the level and structure of executive compensation using Jensen and Murphy (1990)'s data. He presents two versions of principal-agent model and predicts that the structure of executive compensation is a tradeoff between incentives and firm risk. His evidence indicates that for firms with more variable profitability, the correlation between executives' equity-based compensation and firm performance is lower, which confirms the prediction of his model. Using a significantly larger dataset, Aggarwal and Samwick (1999) provide similar evidence that the volatility of firms' stock return is negatively correlated with pay-for-performance sensitivity. They further argue that this is because CEOs in firms with more volatile stock returns tend to hold smaller amounts of firms' shares. Jin (2002) analyzes a theoretical model and predicts that when the CEOs are allowed to trade the market portfolio, the optimal incentive level is negatively correlated with firm-specific risks. Using a large data set from 1992 to 1998, he provides empirical evidence confirming the negative relation between firm specific risk and incentive levels. The non-significant relation between market risk and incentive levels suggests that CEOs can adjust their exposure to market risks. Guo and Ou-Yang (2006) establish a theoretical model in which the manager's utility also depends on his own wealth, and the manager is able to affect not only the firm's expected return but also the firm's risk. They demonstrate that under such settings, the relation between firm value and incentive levels may be either positive or negative, depending on the manager's utility function.

Another stream of studies attempts to relate the seemingly-too-high compensation to firm size. Baker and Hall (2004) present a model and show that how pay-for-performance sensitivity is related to firm size depends on how CEO decisions affect firm value. They estimate the marginal product of CEO effort with respect to firm value to be 0.4, which means that CEO's good effort will partially increase firm value. They also show a weakly negative relation between CEO incentives and firm size. Gabaix and Landier (2008) establish and analyze an equilibrium model in which the CEOs are not paid for their efforts but instead paid for their managerial expertise. They show that in market equilibrium, the most talented CEOs work for the largest firms, and are highest paid. In their model, executive compensation depend not only on firm size, but also on the distribution of firm size in the market. Intuitively, when more firms in the market become larger, more managers, talented or not, get higher pay in equilibrium. Cao and Wang (2009) propose a dynamic equilibrium agency model where CEOs are allowed to search for better outside opportunities. Analyzing the model equilibrium and empirical evidence, they show that both CEO compensation and firm size are increasing with the growth of general economy. He (2011) embeds the optimal contracting problem into the cash flow framework commonly used in capital structure model, in order to take the “debt-overhang” effect into consideration. After deriving the equilibrium of the model, among other results, they find that the manager’s pay-for-performance sensitivity is negatively related to firm size.

Unlike optimal contracting hypothesis, which assumes that remuneration committee of the board can design a sophisticated compensation plan to lower the agency costs caused by the self-interested managers, an alternative view suggests that the managers themselves have influences on their compensations and practically aggravate the agency problem.

Yermack (1997) finds that the timing of option awards coincide with company stock price increases due to good news releases. He takes this result as an evidence of powerful managers influencing their own compensations. Ofek and Yermack (2000) study the relation between stock compensation and managerial ownership, and find that managers tend to sell shares they already own if they are rewarded with firms’ restricted stocks. They also provide further evidence that managers would continue selling shares in the future if they are compensated with more equity incentives or if the firms’ stock price increase substantially. Therefore, they argue that top executives are managing their personal diversified portfolio and would adjust their holdings of firm’s shares according to market conditions and their newly received stock awards.

Bebchuk, Fried, and Walker (2002) claim that the optimal contracting hypothesis is not sufficient in explaining some of the observed evidence in the market, especially the surge of executive compensation in 1990s. Their main argument is that managers can influence their own compensation plans through influencing the board. In addition, they suggest that managers tend to extract excessive pay by camouflaging their compensation, such as replacing cash wages by the excessive amounts of option awards, because options are difficult to value, and are not required to be disclosed in detail at that time. They name this inefficiency in contracting as the “managerial power hypothesis”. Bebchuk and Fried (2003) offer managerial-power explanations for some empirical findings which are puzzling under the optimal contracting framework. For example, they report an inverse relation between CEO incentive compensation and firm size, and argue that this can be well explained by CEO entrenchment. Cheng and Warfield (2005) study the relation between managers’ equity incentives and managers' future trading and earnings management using data from 1993 to 2000. They find that for those managers who received high equity incentives, selling shares are more likely after earnings announcements. They provide further evidence that managers with higher equity incentives are associated with higher frequencies in meeting or beating analysts' forecasts. Combining these results, they claim that high equity incentives lead to earnings management, as the managers are motivated to boost stock prices and profit from selling over-priced firm shares. Bebchuk, Grinstein , and Peyer (2010) study the option grant practices from 1996 to 2005 for the options granted at the lowest price, which they name as the “lucky” grants. They show that the “lucky” grants are deliberately timed to increase their value. In addition to CEOs, independent directors are also found to be receiving “lucky” grants. For CEOs in a firm without an outside blockholder on board, and for the firms with a long-serving CEO, “lucky” grants are more prevalent.

In this chapter, I analyze the effect of stocks awards and stock options on firm performance using static as well as dynamic panel settings. This study differs from the existing studies and contributes to this field in the following ways. Firstly, firms’ performance from last period is included as a determinant of firms’ current performance. This practice avoids the potential omitted variable problem, since the commonly neglected lagged firm performance may be related to current firm performance and the use of equity incentives. To properly solve the endogeneity problem in this setting, I apply difference generalized method of moment (difference GMM) and system generalized method of moment (system GMM) to estimate the parameters. Technical detail is discussed in the coming sections. Secondly, my sample consists of manager-level data, as compared to those who use firm-level data. Data in this level can better reflect the dynamics between executives and firms in contracting as well as the incentive alignment effect on executives. Moreover, with the help of panel data setting, firm unobservable characteristics and executive latent characteristics can also be controlled. Thirdly, the sample in this study consists of almost all firms in the S&P 500, the Midcap 400, and the Smallcap 600, from 1992 to 2009. To my knowledge, this sample is the most “all embracing” dataset in the field of equity incentives researches. Data are collected from 1992 on since the U.S. Securities and Exchange Commission (the SEC) adopted detailed rules on requirement of executive and director compensation disclosure in 1992. In 2006, the SEC adopted significant changes on the disclosure rules, which affect disclosures in proxy statements, annual reports and registration statements, as well as the current reporting of compensation arrangements. I split my data into two sample, one from 1992-2005 and the other from 2006-2009, for all analyses in this chapter because the regulatory changes is so significant that pooling the two sample may falsely neglect the structural break.

3.3 Model Specifications

The main objective of this chapter is to analyze the effect of equity incentives for top executives on firm performance. To properly identify this relation, different assumptions in functional form need to be tested.

Instead of simply assuming exogenous equity incentives, I treat the equity incentives variables as endogenously determined in contracting and are hence related to firms' as well as executives' specific characteristics. Some existing literatures provide evidence showing that executives' equity incentives are affected by firms' observable financial status variables such as firm size, R&D intensity, and growth opportunity as discussed in the literature review section.

In addition to these observable characteristics, some other unobservable factors may also have influence on executive compensation. It is important to recognize that certain unobservable variables, firm specific or executive individual specific, exist that would affect the use of equity incentives and firm performance simultaneously. For example, a firm's corporate governance quality is unobservable, but it is of essential importance in determining how the top executives should be rewarded and incentivized. A firm with better corporate governance system can monitor executives' action with lower cost and consequently provide less equity incentives in executives' compensation package. Otherwise, when the firm's corporate governance is loose and difficult to monitor top executives' decision process, the firm will probably offer more equity incentives to align the executives' personal interest to that of the other shareholders. Analogously, executives' personal unobservable characteristics such as ability and personality are expected to be related with the use of equity incentives for executives and firm performance simultaneously. Existing studies provide evidence that such latent factors are significant and need to be controlled. In this study I will control for the endogeneity problem raised by unobservable firm- and manager-specific characteristics.

Previous empirical works propose different forms of relations between equity incentives and firm performance, one of the most widely used and accepted functional forms is concave relationship. Inverted U-shape is frequently proposed due to the fact that equity incentives have contradicting effects on firm performance, but which one dominates is unclear. For example, firms reward their top executives with firm shares in an attempt to align executives' interests with those of other shareholders and alleviate the agency problem. Such alignment effect implies that the amount of stock awards in executives' compensation has a positive effect on firm performance. However, a certain level of managerial shareholding could also aggravate the agency problem as executives may extract firm resources by establishing high salaries or perquisites. Such management entrenchment effect makes stock awards for executives detrimental to operating efficiency and financial performance of the firm. Also, the managerial power hypothesis claims that executives are influential on deciding their own compensations, and tend to overpay themselves. Since all of alignment effect, management entrenchment effect, and managerial power effect are influencing managerial holdings, non-linear relation between the use of stock awards and firm performance is assumed and applied in the analyses in this chapter.

Awarding executives with stock options of firm's stock also have contradicting effects on firm performance. Stock options give the executives the rights to buy the firm's share at a pre-determined price in the future. These compensations incentivize the executives to concentrate on firms' future performance when making decisions. This alignment effect is similar to that of stocks. An additional advantage of stock options to stocks is that the costs of stock options are lower compared to rewarding executives stocks directly. However, these options are valuable to the executives only when the firm's stock price rises higher than the pre-determined strike price of the options in the future, when the options become exercisable. In other words, when the firm's stock price is too low, these options are valueless for the executives. Such an asymmetric payoff gives the executives incentives to invest in risky projects, in an attempt to boost up the stock price substantially, to make the options valuable and profit from them. Compensating executives with out-of-money stock options may increase the risk of the firm, and it will be catastrophic for the firm if the outcomes of the over-risky projects are not as hoped. The managerial power hypothesis is also valid in the use of option awards. Executives tend to overpay themselves with receiving excessive options, since they are difficult to value and their rent extraction behaviors are less obvious by receiving options. All these contradicting effects of options on firm performance exist, therefore, I also assume a concave relation between the use of stock options and firm performance.

In addition to scrutinizing the contemporaneous relation between equity incentives and firm performance, I also include the firm performance from last period as one of the explanatory variables to allow for the time dependence of firm performance. By extending the static panel model to dynamic setting, two main questions of interest are studied. Firstly, the behavior of time dependency of firm performance is explored. The firm performance will be positively correlated to its previous performance if a momentum effect exists. On the other hand, behavioral finance theories suggest that the firm's Tobin's Q would be negatively related to its lagged value, because the firm was mis-valued previously and is corrected this period. Which effect dominates could be answered by the result of dynamic panel model. Secondly, and more importantly, the relations between equity incentives and firm performance would be studied in a more structured way. Top executives are likely to take the firms' historical performance into consideration when contracting with the firms. Firms are also likely to reward their executives more generously after a good year. Hence one would expect that equity incentives are related to previous firm performance.

A spurious relation between equity incentives and contemporaneous firm performance might be found simply because both of them are related with lagged performance, which is neglected in existing empirical studies. In last chapter, I provide evidence that the inverted U-shaped relation between managerial ownership and firm performance found in static panel setting is not valid when firm performance from last period is also taken into consideration. The spurious effect arises from the fact that both managerial ownership and firm performance are affected by historical firm performance. The sample of that study consists of firm level data. I will test this assumption again with executive level data in this chapter. In addition to stock holdings, the effect of executives' stock options on firm performance will also be analyzed.

3.3.1 Empirical Method

Time dependence of firm performance is usually neglected in the common practices of relating firm performance and equity incentives, as shown in Equation (3.1) below.

$$Q_{it} = \beta_0 + \beta_1 ' \ Equity_{it} + \beta_2 ' \ x_{it} + u_i + e_{it} \tag{3.1}$$

where Q_{it} is the proxy for firm performance, x_{it} is a vector of observable characteristics variables, u_i is a variable summarizing the effect of unobservable time-invariant characteristics (the fixed effect), and e_{it} is the error term , and

$$\beta_1 ' \ Equity_{it} = \beta_3 Stock_{it} + \beta_4 Stock_{it}^{\ 2} + \beta_5 Option_{it} + \beta_6 Option_{it}^{\ 2} \tag{3.2}$$

There are many ways to estimate Equation (3.1), with the most widely used ones being pooled OLS and within estimator.

Pooled OLS

Pooled OLS is the most intuitive and simple way to identify the relation of interest. Estimation with OLS simply ignores the firm- and executive unobservable characteristics, u_i. Weak exogeneity assumption[17] is needed for the OLS estimator to be consistent, in this context, we need $E[X_{it}(u_i+e_{it})]=0$ [18]. Assuming $E[X_{it}e_{it}]=0$, the weak exogeneity assumption holds in this context only when firm- and executive unobservable characteristics do not have an impact on firm performance ($u_i = 0$, for all i), or when firm- and executive unobservable characteristics are not related to firm observable characteristics and equity incentives ($E[X_{it}u_i] = 0$). When the later condition holds, random effect estimator (GLS estimator) is consistent and efficient. However, both of these two conditions are too strict, as almost every variable is related to the others in modern business world.

Within Estimator

A popular way to control for the unobservable firm- and executive characteristics is applying the within estimator. Compared to the rigorously assumptions in OLS and GLS, within estimator only requires a mild assumption that firm unobservable characteristics are time-invariant. To wipe out the fixed effects, for each group, all variables are summed up overtime, and overtime-mean values for each variable are calculated and saved. Since the unobservable fixed characteristics are time-invariant, the overtime average values equal to the corresponding level values. Then all variables are deducted by their overtime means. After this demeaning process the unobservable fixed effects are cancelled out and the OLS estimation for the demeaned equation (Equation (3.3)) is unbiased.

$$Q_{it} - \overline{Q_i} = \beta_1'(Equity_{it} - \overline{Equity_i}) + \beta_2'(x_{it} - \overline{x_i}) + (e_{it} - \overline{e_i}) \qquad (3.3)$$

This fixed effect model is widely used in researches with panel data setting, because

[17] Since u_i is not explicitly modeled in OLS, the error term is now $\varepsilon_{it}= u_i+e_{it}$, weak exogeneity of ε_{it} is needed for the consistency of OLS estimator.

[18] X_{it} is a vector including all regressors.

it is consistent as long as the functional form of the relationship (Equation (3.1)) is a good approximate of the true effect. Besides the convenience, however, the application of fixed effect estimators has a major drawback. To cancel out the unobservable effects, a demeaning process is carried out as shown above. After this process, only the within group variations are left for estimating the parameters. If the executive compensation components and other firm observable characteristics, manager observable attributes also vary slowly overtime, the left-over variations may be too small to have stable parameter estimates. This potential problem could be solved by including data from longer periods. Considering the fact that the sample in this study consists of 18 years' data, this theoretical drawback is not a main concern.

To check the validity of applying within estimator, I will also carry out two tests to check the two previously mentioned conditions, i.e. firm unobservable characteristics do not have an impact on firm performance ($u_i = 0$, for all i), or firm unobservable characteristics are not related to firm observable characteristics ($E[X_{it}u_i] = 0$). To check the former, I carry out an F-test with the null hypothesis being $u_i = 0$ for all i. If the null hypothesis is rejected, then firm unobservable characteristics have an impact on firm performance. To check the later, I carry out a Hausman test comparing the estimation coefficients of within estimator and GLS estimator. The null hypothesis of the Hausman test is that the differences between coefficients estimated from within estimator and those from GLS estimator are not systematic. If the null hypothesis is rejected, then GLS estimator is not consistent and within estimator is consistent and should be used[19].

[19] However, the Hausman test for misspecification requires the assumption that the within estimator is consistent under both H_0 and H_1, and the GLS estimator is consistent and efficient under H_0 but inconsistent under H_1. Again, this assumption is fulfilled as long as Equation (3.2) is a good approximate of the true relationship between firm performance and managerial ownership. See, for example, Chapter 9 of Greene (2008), Chapter 10 of Woodridge (2002) for more in-depth discussions about OLS, within estimator, and GLS estimator in static panel settings.

Difference GMM and System GMM

The above specification is in static panel settings, which neglect the relationship between firm performances in different periods. In this specification, I use dynamic panel setting in order to allow for the time dependence of firm performance. As discussed above, firm performance this period is likely to be affected by its performance from last period. In this case, the functional form is shown in Equation (3.4), with all variables defined as above.

$$Q_{it} = \beta_0 + \gamma Q_{it-1} + \beta_1 ' \, Equity_{it} + \beta_2 ' \, x_{it} + u_i + e_{it} \tag{3.4}$$

When autocorrelation exists in the model, the within estimator is not consistent anymore. The within estimator solves the problem of the unobserved fixed effect, by demeaning the whole equation and thereby wipe out u_i. The within estimator is unbiased and consistent, however, only in the static model, i.e., Q_{it-1} is not one of the regressors. In the dynamic model, the demeaning process eliminates the individual fixed effects, but at the mean time introduces another endogeneity problem. The new problem arises due to the fact that Q_{it-1} and its mean are correlated with the mean of e_{it}. Nickell (1981) derived the asymptotic bias to be $-(1+\gamma)/(T-1)$, for large T and the number of observations goes to infinity. This bias does not vanish even for infinitely many time periods, i.e., even for T goes to infinity, the within estimator is still inconsistent.

A comforting fact is that the within estimator and the OLS estimator are biased to opposite directions. For example, when the OLS estimator is biased upwards, the within estimator would be biased downwards (as shown in Nickell (1981)). This gives us a “consistent range”. We can expect that a consistent estimator gives results lying between the estimates from OLS and those from the within estimator.

In dynamic panel setting, several candidate consistent estimators are available. The first candidate considered in this study is the difference generalized method of moments (difference GMM) estimator proposed by Arellano and Bond (1991). Equation (3.4) is transformed to Equation (3.5) by taking the first difference as following.

$$\Delta Q_{it} = \gamma \Delta Q_{it-1} + \beta_1 ' \ \Delta Equity_{it} + \beta_2 ' \ \Delta x_{it} + \Delta e_{it} \qquad (3.5)$$

where $\Delta \mathrm{e}_{\mathrm{it}} = \mathrm{e}_{\mathrm{it}} - \mathrm{e}_{\mathrm{it-1}}$, and other differenced variables are defined analogously.

Since the stochastic error terms should not have a shock retrospectively, the level of variables before period t-1 should be independent of the differenced error terms. Hence, we can make use of the orthogonality condition $E[W_{it-2}\Delta e_{it}]=0$, where the matrix W can contain the firm performance and all the firm characteristics including stock awards variables and option awards variables, or in the most efficient case, all of them. All previous lags, W_{it-3}, W_{it-4}, …W_{i0} are also valid instruments, and thus should be included in the estimation.

Another widely used candidate of consistent identification strategy is system GMM proposed by Arellano and Bover (1995) and fully developed by Blundell and Bond (1998). It is an extension of difference GMM by including more moment conditions and making use of the residuals of the level equation (Equation (3.4)). The additional orthogonality conditions exploited are $E[\Delta W_{it-1}(u_i + e_{it})] = 0$ and that of further lags. These conditions are based on the assumptions that the error terms this period should be independent of the changes of the regressors and the changes of dependent variable of last period and earlier. More moment conditions are included in order to exploit more information from the data set and increase efficiency. The cost for such efficiency gains is a mild assumption that the changes in explanatory variables are independent of the fixed effect and the error terms in later period. These new conditions together with the conditions used in difference GMM model compose the system GMM estimator.

These two estimators strongly rely on the behavior of error term. It is assumed that the error terms are independently distributed over time. Then the differenced error term in Equation (3.5), Δe_{it}, should follow an MA(1) process. If this assumption fails to hold, for example, when the original error terms follow an MA(1) process, then their first difference would follow an MA(2) process. This will reject many of the orthoganality conditions used above, and the difference GMM estimator and system GMM estimator might not be consistent. Arellano and Bond (1991) introduce some tests to test the behavior of the error terms. I will perform these tests when applying the difference GMM estimator and system GMM estimator[20].

The risk of over-fitting the endogenous variables should be recognized, since there are too many instruments used in these two specifications. Here I report the results of two J tests for over-identifying restrictions, Sargan test and Hansen test. Sargan test provided by Arellano and Bond (1991) is not robust to heteroskedasticity or autocorrelations, but robust to many instruments used; while Hansen test is robust to the distribution of error terms, but can be weaken with too many instruments. Considering the strength and weakness of these two J tests, the results of both would be reported and reviewed complementarily.

By extending the static panel model to dynamic setting, two main questions of interest are studied. Firstly, the behavior of time dependency of firm performance is explored. Secondly, the relationship between equity incentives and firm performance would be studied in a more structured way. Obviously, firm performance from last period would affect the executives' compensation this year, including their stock awards and option awards. Influential managers are also likely to increase their own awards after a good year. Hence one would expect that executive equity incentives are related to lagged firm performance. Possibility exists that contemporaneous executive equity incentives are related to firm performance only because both of them are affected by historical firm performance. Dynamic panel models can help us distinguish this artificial relationship from the real effects.

[20] Please see Arellano and Bond (1991) for more detailed descriptions of these tests.

3.3.2 Proxy Variables

The main variables of interest are firm performance, stock awards, and option awards. This section discusses the choice of measurements of these variables. Moreover, the firm observable characteristics need to be controlled, i.e. the variables included in vector x_{it} are also introduced.

Firm Performance

Tobin's Q is a widely used proxy for firm performance in empirical works. It measures how much higher the market value of equity is compared to the book value of equity. Not only as a performance measure, but it can also be used as a valuation measure and a growth measure. It also reflects investment opportunities that have been acquired or developed and in that sense it is connected to the firm's growth potential. Himmelberg, Hubbard, and Palia (1999) calculate the Tobin's Q, defined as the ratio of the value of the firm divided by the replacement value of assets. In this chapter I will stick to their calculation of Tobin's Q and use it as the proxy for firm performance. For firm value, I use the market value of common equity plus the estimated market value of preferred stock (roughly estimated as ten times the preferred dividend) plus the book value of total liabilities. For replacement value of assets, the book value of total assets is used.

$$Q = \frac{\text{MV of Common Equity} + \text{Preferred Stock Dividends} \times 10 + \text{BV of Total Liabilities}}{\text{BV of Total Assets}}$$

Stock Awards

This variable is the aggregate value of all kinds of stock-related awards, such as restricted stock, phantom stock, common stock equivalent units etc. The value is calculated in accordance to the valuation rules of shares as described in FAS123R.

The values of stocks are directly linked to the companies' future performance, and the payoffs of stocks are symmetric and forward-looking. Because of these attractive features of restricted stocks, they are the primary instrument firm uses to align the interest of executives to shareholders' interest.

Option Awards

Option awards variable covers all instruments with option-like features, such as stock options and stock appreciation rights. The SEC adopted changes to the disclosure and valuation of option awards to executives in 2006, therefore the calculations of this variable before and after 2006 substantially differ. More details in these regulation changes will be discussed in next section. This variable is calculated as the value of in-the-money unexercised exercisable options and unexercisable options as reported by the company at fiscal year end for observations from 1992 to 2005; for observations from 2006 to 2009, it is calculated as the estimated aggregate value of in-the-money vested options and unvested options at fiscal year end, computed based on the difference between the exercise price of the options and the close price of the company's primary issue of stock at year end. The valuation process is based on FAS123R as required by the SEC.

Stock options give the executives the rights to buy the firm's share at a pre-determined price in the future. These compensations incentivize the executives to concentrate on firms' future performance when making decisions which effectively align executives' interests with those of other shareholders. However, option awards differ from stock awards in certain important aspects. Firstly, unlike stocks, the payoffs of stock options are asymmetric, and compensating executives with out-of-money stock options may increase the risk of the firm. Secondly, even when the stock options are in-the-money, their payoffs still differ from the payoffs of shareholders, due to the fact that holding stock options are not receiving dividends as holding shares. Due to these differences, I will separately analyze the effects of option awards and those of stock rewards to firm performance in this chapter.

Firm Size

One of the firm observable characteristics of great importance is firm size. The effect of firm size on the amount of executive compensation is intuitive and is proved. Evidences include Core and Guay (1999), who show that CEOs' equity incentives are positively related to market value of equity, Gabaix and Landier (2008), who argue that executives' level total pay should increase with firm size, and others. But the effect of firm size on firm performance is not monotonic. For example, the monitoring cost of large firm may be high due to bureaucracy and inefficient communication, indicating that larger firms have higher agency costs. On the other hand, the operating costs and production costs of large firm may be lower because of scale of economy, which implies that larger firms higher better financial performance. Hence, the effect of firm size on the use of equity incentives as a fraction of total compensation and on financial performance is unclear. Here I use the logarithm of sales, LN(S), as the proxy for firm size. The square of log sales, $LN(S)^2$, is also added in the model, to allow for nonlinearity.

Monitoring Power

As previously discussed, the quality of a firm's corporate governance and hence the monitoring power of the board has a significant influence on the structure of compensations to incentivize executives. A firm with better corporate governance system can monitor executives' action more easily and hence have lower agency costs. Otherwise, when the firm's corporate governance is loose and difficult to monitor top executives' decision process, the firm will probably offer more equity incentives to align the executives' personal interest to that of the other shareholders. Unfortunately the costs of firms used to monitor their executives are not directly observable. To measure monitoring power, I used the importance of fixed capital as a proxy variable, because fixed capital is easy to monitor. If a firm has a large portion of fixed capital, it is difficult for the executives to entrench themselves or be extravagant at the cost of shareholders' wealth. A common practice is to use the ratio of property, plant, and equipment to sales, K/S, as a measure of the importance of fixed capital in the firm. Its squared term, $(K/S)^2$, is also included to allow for nonlinearity, if exists.

Risk of Firm's Equity

Another important determinant of executive compensation structure is the risk of firm's equity. Except for financial return of the equity, the other side of the tradeoff, the risk of the equity is also a concern of shareholders. Risk sharing is a mechanism widely used in modern business world. For firms' with more volatile equity prices, their executives probably receive more equity incentives. The causal effect may also be reversed. As shown in Bergstresser and Philippon (2006), CEOs with higher level of equity incentives are more likely to manipulate reported earnings to boost stock prices. Also, they find evidence that CEOs' sell large blocks of shares and exercise large amounts of options during years of high accruals. Ryan and Wiggins (2001) find that the volatility of operating cash flows is negatively related to cash bonuses but positively related to stock options. Therefore the volatility of stock price is used as a proxy of equity risk and is included in the analyses. There are relatively many observations with missing data in stock volatility, I set the missing volatility to zero and add dummy variables accordingly to indicate whether the original data is available, in order to maintain sample size.

Free Cash Flow

The ratio of operating income to sales is included as a proxy for market power of firms' free cash flows, which is defined is the cash flow left after profitable projects are invested. It measures the gross cash flows available from operations. Jensen (1986) argues that when a firm has sufficient free cash flows, the manager may use the cash to invest in non-profitable projects, rather than paying out to shareholders as dividends. Therefore, he suggests that equity incentive is positively related to a firm's market power of free cash flows. Operating income to sales is used to measure the firms' free cash flows, and is included in the analyses to control for its possible effect on firm performance.

R&D Intensity

R&D intensity is an important factor for executive compensation for the following reasons. Firstly, R&D intensive firms are mainly high growth firms. For these firms, the focus is future payoffs of investment decisions rather than the costs of projects or operating efficiency. The potential upward effect on equity price is enormous, if the R&D results turn out to be positive for the firm's future. To incentivize the executives to make right decisions as well as to share the risks, firms with high R&D costs will compensate their executives with large portions of restricted stocks and stock options. Kole (1997) shows that more research-intensive firms tend to offer their executives more equity-based awards. The proxy for R&D intensity is the ratio of R&D expenditures to fixed capital of the firms. I also set the missing values to zero and include a dummy variable indicating missing R&D expenditure for the same reason of maintaining sample size.

Growth Opportunities

Similar to R&D intensity, growth opportunities of the firms are expected to have positive effects on executives' equity incentive as well as firm performance, as growth opportunities are also forward looking. Core and Guay (1999), for example, find that the optimal amount of restricted stocks and stock options in executive compensations depends on growth opportunities. The ratio of capital expenditure to fixed capital, and the ratio of advertising expenditure to fixed capital are used to control for the firms growth opportunities in this chapter. There are relatively many observations with missing data in advertising expenditure. In order to maintain sample size, I also set the variable to zero when missing, and add a dummy variable to indicate whether the original data is available.

Variable descriptions are summarized in Table 3.1.

TABLE 3.1 Variable descriptions

Variable	Description
Q	Tobin's Q, defined as the ratio of the value of the firm divided by the replacement value of assets. For firm value, I use the market value of common equity plus the estimated market value of preferred stock (roughly estimated as ten times the preferred dividend) plus the book value of total liabilities, and for replacement value of assets I use the book value of total assets. This definition is closely related to the market-to-book ratio, which is easily seen by subtracting total liabilities from both the numerator and denominator
Stocks	The aggregate market value of restricted shares held by the executive as of fiscal year end Units: Million $
Options	1992-2005: Value of in-the-money unexercised exercisable options and unexercisable options as reported by the company at fiscal year end 2006-2009: The estimated aggregate value of in-the-money vested options and unvested options at fiscal year end, calculated based on the difference between the exercise price of the options and the close price of the company's primary issue of stock at year end Units: Million $
LN(S)	The natural log of sales, used to measure firm size
K/S	The ratio of tangible, long-term assets (property, plant, and equipment) to sales, used to measure the alleviation of agency problems due to the fact that such assets are easily monitored and provide good collateral
Sigma	The standard deviation of idiosyncratic stock price risk, directly available in Compustat
Sig_dum	A dummy variable equal to unity if the data required to estimated SIGMA is available, and otherwise equal to zero (if SIGMA is missing). To maintain sample size and reduce the risk of sample selection bias, I set missing observations of SIGMA equal to zero, and then include this dummy variable to allow the intercept term to capture the mean of the SIGMA for missing values
Y/S	The ratio of operating income to sales, used to proxy for market power of cash flows and measure the gross cash flows available from operations
(R&D)/K	The ratio of research and development expenditures to the stock property, plant, and equipment, used to measure the role of 'R&D capital' relative to fixed capital
R&D_dum	A dummy variable equal to unity if R&D data were available, and otherwise equal to zero
A/K	The ratio of advertising expenditures to the stock of property, plant, and equipment, used to measure the role of 'advertising capital' relative to fixed capital
A_dum	A dummy variable equal to unity if advertisement data were available, otherwise equal to zero
I/K	The ratio of capital expenditures to the stock of property, plant, and equipment

Data Source: Stocks and Options are extracted from ExecuComp, definitions of these variables also from ExecuComp; Corporate Financial variables are extracted from Compstat. Some definitions of Corporate Financial variables are from Himmelberg et.al (1999).

3.4 Data

3.4.1 Data Sources

The sample in this study is constructed in the form of the popular ExecuComp - Compustat combination. The dollar amounts of stock awards and option awards in executives' compensation packages are extracted from ExecuComp. ExecuComp provides information of executives of firms in the S&P 500, the Midcap 400, and the Smallcap 600. Company basic financial data are collected from Compustat. Data from Compustat are combined with the ExecuComp data using GVKEY as the unique identifier for companies.

The ExecuComp database consists of data from 1992 to 2009 for regulation reasons. Before 1992, listing companies are only required to disclose the executive and director compensations in the narrative disclosure. The U.S. Securities and Exchange Commission (the SEC) adopted changes to the rules requiring executive and director compensation disclosed not only in the narrative disclosure but also in the tabular disclosure from 1992.

Financial Accounting Standards Board (FASB) issued the Statement of Financial Accounting Standards No. 123 (revised 2004, FAS 123R) that would be effective after June 15, 2005, requiring a public entity to recognize the cost of employee services received in share-based payment transactions, thereby reflecting the economic consequences of those transactions in the financial statements. From the end of 2005, public companies have to adopt FAS 123R's fair-value-based method of accounting for share-based payment transactions with employees. In deciding the fair values of options, firms can choose from the Lattice model, the Black-Scholes model, the Monte Carlo simulation model. Necessary inputs for option pricing models include stock price on grant date, expected maturity, exercise price, expected volatility of stock price, expectation of dividend payments, and risk free rate within the maturity of the options. The entity can use the straight-line method to amortize the share-based payment through the period during which an employee is required to provide service in exchange for the award, namely the requisite service period (usually the vesting period). These changes in requirement have substantial effects not only on the disclosure and valuation method of executives' option awards, but also on the firms' financial performance and accounting ratios. Therefore, it is necessary to split the sample into two parts, one from 1992 to 2005 and one from 2006 to 2009, and apply the analyses separately.

To be included in the sample, the observations must have detailed breakdown of total compensation data according to SEC's requirements for at least one year in the range of 1992-2009. Observations with missing data in sales, total assets, total liabilities, property, plant & equipment (PP&E), operating income, and market capitalization are excluded from the sample. There are relatively many observations with missing data in stock volatility, R&D expenditure, and advertising expenditure. In order to maintain sample size, I set these variables to zero when they are missing, and add dummy variables accordingly to indicate whether the original data is available. After refining the dataset, my sample consists of 119801 observations in 2748 companies in the 1992-2005 subsample, and 32991 observations in 1992 companies in the 2006-2009 subsample.

3.4.2 Descriptive Statistics

Descriptive statistics of the first subsample are provided in Table 3.2A. During

1992-2005, top executives received firm shares with an average worth of 0.75 million dollars, and the average value of the option awards amounts to 4.81 million USD. Table 3.2B provides the descriptive statistics of the 2006-2009 subsample. It shows that in the compensation package of an average executive, the value of stock awards increased to 1.23 million USD, which is significantly higher than the average amounts they received before 2005. The mean value of option awards were 3.59 million USD. Though this figure is not directly comparable with its counterpart in 1992-2005 data due to the difference in valuation methods and regulation requirements, a general conclusion that the use of options in executive remunerations are less paramount is not unacceptable. An increase in the value of stock awards and simultaneously a decrease in the value of option awards may be implicative for the firms' intensions and concerns. Realizing that out-of-money options may lead to over risk-taking behaviors, firms reward their executives with less option awards in an attempt to avoid redundant risks. Stock awards were increased accordingly in order to maintain the total amount of equity incentives, and maintain the power of equity incentives in aligning executives' interests with those of other shareholders.

TABLE 3.2A Descriptive Statistics – 1992-2005 Sample

Variable	N	Mean	Std. Dev.	1st Quartile	3rd Quartile
Q	119801	2.086	2.408	1.155	2.232
Stocks	119801	0.750	21.572	0.000	0.100
Options	119801	4.810	56.099	0.050	2.656
LN(S)	119801	6.947	1.632	5.898	7.982
K/S	119801	0.494	2.005	0.116	0.456
Sigma	119801	4.918	15.552	0.000	0.000
Sig_dum	119801	0.113	0.317	0.000	0.000
Y/S	119801	0.011	5.091	0.088	0.247
(R&D)/K	119801	0.324	5.115	0.000	0.136
R&D_dum	119801	0.522	0.500	0.000	1.000
A/K	119801	0.086	0.476	0.000	0.012
A_dum	119801	0.270	0.444	0.000	1.000
I/K	119801	0.233	0.207	0.110	0.313

Source: Compiled by author. Units for the Stocks and Options: Million $.

TABLE 3.2B Descriptive Statistics –2006-2009 Sample

Variable	N	Mean	Std. Dev.	1st Quartile	3rd Quartile
Q	32991	1.844	2.000	1.106	2.086
Stocks	32991	1.232	5.596	0.000	0.945
Options	32991	3.586	15.888	0.000	1.989
LN(S)	32991	7.374	1.651	6.260	8.439
K/S	32991	0.357	0.621	0.087	0.335
Sigma	32991	29.723	21.425	18.700	42.080
Sig_dum	32991	0.776	0.417	1.000	1.000
Y/S	32991	0.113	1.545	0.079	0.240
(R&D)/K	32991	0.479	2.051	0.000	0.204
R&D_dum	32991	0.546	0.498	0.000	1.000
A/K	32991	0.151	0.835	0.000	0.055
A_dum	32991	0.403	0.490	0.000	1.000
I/K	32991	0.316	4.483	0.120	0.320

Source: Compiled by author. Units for the Stocks and Options: Million $.

3.5 Empirical Results

The main objective of this chapter is to analyze the effect of equity incentives for top executives on firm performance. As discussed in model specification section, I will first carry out the analyses in static panel settings to analyze the contemporaneous relations, and then in dynamic panel settings to allow for time dependency in firm performances. The amounts of equity incentives for executives are assumed to be endogenously determined in contracting. Therefore firms' observable financial variables as well as unobservable firm- and manager specific characteristics are controlled. The effect of firm performance from the previous period is also controlled in the dynamic panel specifications. The functional form of the relation is assumed to be concave. Due to the substantial changes in disclosure and valuation requirements adopted by SEC in 2005, all the analyses are carried out in two separate subsamples, one from 1992 to 2005 and the other from 2006 to 2009.

3.5.1 Effect of Equity Incentives on Firm Performance - Static Panel Specifications

Table 3.3A presents the OLS estimation results for the relation between the amounts of equity incentives rewarded to executives and firm performance. The second and the third columns report the results for the 1992-2005 subsample. The stock awards the executives receive are shown to be non-linearly related to firm performance, when no other observable firm characteristics are included in the model. Estimation results indicate that the relation is U-shaped. But since the turning point of the U shape is calculated to be 2.3 billion USD, which is unrealistic to reach, the effect of managerial stock awards on firm performance is actually negative. The relation between executives' option awards and firm performance is found to be inverted U-shaped. Similarly, the turning point is calculated to be unrealistically large (8.4 billion USD), the effect of executives' option awards on firm performance is practically concavely positive. The negative effect of stock awards fails to be significant when the firm's other financial variables are included in the estimation, as shown in the second column of Table 3.3A, while the inverted U-shaped relation between option awards and firm performance remains robust with the turning point also stay close to 8.4 billion USD.

The results of OLS estimation using the 2006-2009 subsample are presented in the fourth and the fifth column. The patterns of the results are similar to those of 1992-2005 subsample. For stock awards, a positive effect is found when no other observable financial variables are controlled. But this relation vanished when the firm's other financial characteristics are controlled. The effect of executives' option awards on firm performance is much more robust. Consistent with the findings using 1992-2005 subsample, the relation is found to be inverted U-shaped. The turning points are estimated to be about 450 million USD, which are much smaller compared to those of 1992-2005 subsample. But considering the fact that the mean option awards in 2006-2009 subsample is 3.6 million USD, the turning points are too high to reach. Therefore, the effect of executives' option awards on firm performance is also practically concavely positive.

As previously discussed, firm's unobservable characteristics are likely to be simultaneously correlated with firm performance and the use of equity incentives and hence should not be neglected. Table 3.3B reports the estimation results using within estimator, controlling for firm fixed effect. The negative relations between stock awards and firm performance found in OLS estimations are not statistically significant when firm fixed effects are controlled. The positive effects of option awards on firm performance for both subsamples are very similar to the estimations using OLS, including the locations of turning points.

The bottom of Table 3.3B also reports the results of F-tests for fixed effect. The null hypothesis of this F-test is that the fixed effects for all firms are all zero. The results indicate that firm firm's unobservable characteristics do have an impact on firm performance. To more formally test the effect of unobservable individual fixed characteristics, I also carry out the Hausman test for misspecifications. Hausman specification test requires the model estimated twice, by within estimator and GLS estimator respectively, then the error term structures of these two estimators are compared. Intuitively speaking, if the assumption of Hausman test holds, rejection of the null hypothesis indicates that the firm fixed effects, or the unobserved heterogeneities, are correlated with the other regressors. Test results reported clearly reject the assumptions that firm fixed effect is not affecting managerial ownership or firm fixed effect is uncorrelated with firms' other observable characteristics, which justifies the use of within estimators.

In addition to firm's unobservable characteristics, executives' individual characteristics are also deciding factors for firm performance and the use of equity incentives. Table 3.3C reports the estimation results using within estimator, controlling for firm fixed effect and executive individual fixed effect. The results for 1992-2005 subsample are consistent with previous presented evidence. Stock awards of executives had no effect on firm performance during 1992-2005. A weak concave relation between stock awards and firm performance is found in subsample 2006-2009 when no other observable financial variables are controlled. But this relation vanishes when the firm's other financial characteristics are controlled. In both subsamples, the inverted U-shaped relations between executives' option awards and firm performance remain statistically significant, and the calibrations of the effects remain similar. The results of F-tests for fixed effects and Hausman test show that firm- and individual unobservable characteristics are correlates with the use of equity incentives and other observable firm characteristics, and should not be neglected.

As discussed before, firm performance is suspected to be autoregressive. If this conjecture is true, then the error terms in static panel specification would show an autoregressive pattern. To formally test this assumption, I estimate and retain all the residuals in these specifications and carry out a test for serial correlation in residuals of panel data models, proposed by Wooldridge[21]. The results shown clearly reject the hypothesis of no serial correlation in residuals of static panel model. This finding justifies my later analyses of including the lagged performance in the models.

[21] See Wooldridge (2002), pp. 282-283 for more details.

TABLE 3.3A Effects of Equity Incentives on Firm Performance – Pooled OLS (with Equity Incentives in level)

Variable	1992-2005 Sample Pooled OLS		2006-2009 Sample Pooled OLS	
Stocks	-0.008***	-0.002	-0.009***	-0.010
	(0.003)	(0.002)	(0.003)	(0.007)
Stocks^2	1.8E^{-06} ***	5.0E^{-07}	7.6E^{-06}	5.6E^{-06}
	(0.000)	(0.000)	(0.000)	(0.000)
Options	0.020***	0.019***	0.015***	0.018***
	(0.003)	(0.003)	(0.001)	(0.002)
Options^2	-1.2E^{-06} ***	-1.1E^{-06} ***	-1.7E^{-05} ***	-2.0E^{-05} ***
	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-1.114***		-1.785***
		(0.060)		(0.683)
LN(S)^2		0.064***		0.108**
		(0.004)		(0.043)
K/S		-0.063***		-0.064*
		(0.015)		(0.033)
(K/S)^2		0.000***		-0.008
		(0.000)		(0.007)
Sigma		-0.005***		0.003
		(0.001)		(0.005)
Sig_dum		0.308***		-0.107
		(0.049)		(0.153)
Y/S		0.018***		0.017
		(0.004)		(0.011)
(R&D)/K		-0.003***		-0.022
		(0.001)		(0.032)
R&D_dum		0.453***		0.271***
		(0.013)		(0.020)

A/K		0.133***		0.025*
		(0.023)		(0.014)
A_dum		0.190***		0.213***
		(0.018)		(0.018)
I/K		2.384***		-0.004***
		(0.163)		(0.001)
Adj. R^2	0.06	0.18	0.02	0.11
Wald	16.16	17.01	45.07	49.54
p-value (Wald)	0.00	0.00	0.00	0.00
AIC	543421	526750	138766	135405
BIC	543595	527041	138834	135573

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"Wald" and "p-value (Wald-test)" are test statistics and their corresponding p-values of the Wald tests for joint significance of managerial holding variables.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

TABLE 3.3B Effects of Equity Incentives on Firm Performance – Firm Fixed Effects (with Equity Incentives in level)

Variable	1992-2005 Sample Firm Fixed Effect		2006-2009 Sample Firm Fixed Effect	
Stocks	-0.001	-0.002	-0.000	-0.001
	(0.002)	(0.002)	(0.001)	(0.003)
Stocks^2	2.4E^{-07}	4.4E^{-07}	-1.8E^{-06}	9.8E^{-07}
	(0.000)	(0.000)	(0.000)	(0.000)
Options	0.013***	0.013***	0.004***	0.004***
	(0.004)	(0.004)	(0.001)	(0.001)
Options^2	-7.7E^{-07} ***	-7.6E^{-07} ***	-4.2E^{-06} ***	-4.7E^{-06} ***
	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-1.545***		-3.082
		(0.448)		(2.946)
LN(S)^2		0.080***		0.189
		(0.028)		(0.206)
K/S		-0.183***		-0.498*
		(0.055)		(0.279)
(K/S)^2		0.001***		0.029
		(0.000)		(0.021)
Sigma		-0.009**		-0.012
		(0.004)		(0.012)
Sig_dum		0.311**		0.178
		(0.155)		(0.336)
Y/S		-0.005		0.068
		(0.011)		(0.061)
(R&D)/K		-0.003***		-0.252
		(0.001)		(0.300)
R&D_dum		-0.001		-0.043
		(0.070)		(0.084)

A/K		0.405**		0.190
		(0.172)		(0.147)
A_dum		-0.269***		0.003
		(0.091)		(0.231)
I/K		1.690***		-0.003
		(0.452)		(0.228)
Overall R^2	0.05	0.14	0.01	0.06
p-value (F-test)	0.00	0.00	0.00	0.00
Hausman	953.59	2527.07	42.37	117.40
p-value (Hausman)	0.00	0.00	0.00	0.00
Wald	58.61	86.57	9.36	9.47
p-value (Wald)	0.00	0.00	0.00	0.00
AIC	481196	475988	105547	103709
BIC	481351	476270	105606	103868

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

"Wald" and "p-value (Wald-test)" are test statistics and their corresponding p-values of the Wald tests for joint significance of equity incentive variables.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

TABLE 3.3C Effects of Equity Incentives on Firm Performance – Firm & Individual Fixed Effects (with Equity Incentives in level)

Variable	1992-2005 Sample Firm & Invd. Fixed Effect		2006-2009 Sample Firm & Invd. Fixed Effect	
Stocks	0.000	-0.001	0.006**	0.003
	(0.001)	(0.001)	(0.003)	(0.004)
Stocks^2	-1.5E^{-08}	1.6E^{-07}	-1.3E^{-05} ***	-7.2E^{-06}
	(0.000)	(0.000)	(0.000)	(0.000)
Options	0.015***	0.016***	0.012***	0.014***
	(0.004)	(0.004)	(0.002)	(0.002)
Options^2	-9.1E^{-07} ***	-9.2E^{-07} ***	-2.1E^{-05} ***	-2.4E^{-05} ***
	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-1.130***		-4.331
		(0.227)		(2.696)
LN(S)^2		0.054***		0.274
		(0.015)		(0.190)
K/S		-0.183***		-0.518***
		(0.024)		(0.155)
(K/S)^2		0.001***		0.028**
		(0.000)		(0.012)
Sigma		-0.002		-0.018
		(0.002)		(0.012)
Sig_dum		0.032		0.371
		(0.064)		(0.371)
Y/S		-0.003		0.093*
		(0.005)		(0.052)
(R&D)/K		-0.002***		-0.307
		(0.001)		(0.236)
R&D_dum		0.009		-0.045
		(0.035)		(0.037)

A/K		0.232***		0.207**
		(0.054)		(0.103)
A_dum		-0.199***		-0.012
		(0.038)		(0.175)
I/K		1.071***		-0.070
		(0.143)		(0.154)
Overall R^2	0.05	0.14	0.02	0.06
p-value (F-test)	0.00	0.00	0.00	0.00
Hausman	999.41	1727.24	20.81	-256.84
p-value (Hausman)	0.00	0.00	0.00	--
p-value (serial corr.)	0.00	0.00	0.00	0.00
Wald	400.03	506.71	20.99	18.56
p-value (Wald)	0.00	0.00	0.00	0.00
AIC	410318	407507	104249	101776
BIC	410483	407779	104307	101944

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

“p-value (F-test)” reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero.

“Hausman” and “p-value (Hausman)” report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

“Wald” and “p-value (Wald-test)” are test statistics and their corresponding p-values of the Wald tests for joint significance of equity incentive variables.

“p-value (serial corr.)” reports the p-values of Wooldridge’s test for serial correlation in the errors terms of panel models. e.g., a p-value of 0 rejects the null hypothesis that there is no first order autocorrelation in the error terms.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

To summarize the evidence provided in Table 3.3A - Table 3.3C, no conforming relation is found between the amounts of stock awards for executives and firm performance. An inverted U-shaped relation is found between the use of option awards and firm performance, but since the theoretical optimal points of option awards are too high to be realistic, the relation between the two is actually concavely positive. Intuitively, firm performance increases with the option awards for executives at decreasing rates, when firm performance is measured as Tobin's Q. Moreover, empirical evidence shows that firm- and individual-unobservable characteristics have impacts on firm performance, and are also correlates with the executives' equity incentives and other observable firm characteristics.

In a first attempt to study the inter-temporal relation between executives' equity incentives and firm performance, I also do the above analyses with equity incentives from last period as well as the changes of equity incentives from last period to current period. The results are presented in Table 3.4A - Table 3.4C, Table 3.5A - Table 3.5C, respectively, which could be found in the Appendix.

Some interesting evidence of the relation between firm performance and the stocks rewarded to executives in last period is found. For 1992-2005 subsample, estimations using OLS return no statistically significant relation between the two, but an inverted U-shaped relation is found between the use of stock awards from last period and current firm performance when firm- and individual unobservable characteristics are controlled. The turning points are calculated to be around 2.2 billion USD, which are also too high to be realistic. Since only the left part of the inverse U shape is relevant, we can argue that stock awards of executives from last period has a positive effect on current firm performance. The results of 2006-2009 subsample are the opposite, i.e. a U-shaped relation is found between the use of stock awards from last period and current firm performance. Considering the high turning points, one can interpret this relation as a negative effect of lagged stock awards on current firm performance. Using 1992-2005 subsample, the effect of executives' option awards from last period on current firm performance is consistent with those of executives' current option awards, i.e. inverted U-shaped relation. The turning points of the inverted-U shapes also locate in the near of 8.4 billion USD, therefore the relation between lagged executives' option awards and current firm performance can be inferred as concavely positive. These effect also exist in 2006-2009 subsample but much weaker. The results presented in Table 3.4A - Table 3.4C show that from 1992 to 2005, the amounts of stock awards and option awards in executive compensations of last year have a concavely positive effect on firm performance this year, while the lagged stock awards has a negative effect on firm performance from 2006 to 2009. Firm fixed effect as well as individual fixed effect are confirmed to be prominent and should be controlled for.

The relations between changes of executives' equity incentives and firm performance are also studied and the empirical results are reported in Table 3.5A - Table 3.5C. The changes in executives' stock awards and firm performance are shown to be non-linearly related in both subsamples, with the functional forms to be U shapes. The turning points of the U shapes are estimated to be around negative 4 billion USD, which is not probably realistic, therefore only the right parts of the U shapes are considered relevant. This interesting result can be interpreted as firm performance is increasing with changes of executives' stock awards at increasing rates. For changes in executives' option awards, only weak positive effects are shown in 2006-2009 subsample. Consistent with previous findings, firm- and individual unobservable characteristics are found to be correlated with the regressors.

To summarize the evidence provided using static panel specifications, I find that firm performance is increasing with the option awards for executives at decreasing rates from 1992-2009. No statistically significant relation is found between executives' stock awards and firm performance in the same period. Both the amounts of executives' stock awards from last period and the changes of stock awards have positive effect on firm performance from 1992 to 2005. From 2006 on, the changes of executives’ stock awards are positively related to firm performance, while the stock awards executives received from last period are negatively related to the firms’ current performance. Firm performance are found to be positively related to executives’ option awards from last period from 1992 to 2005, and positively related to the changes of option awards from 2006 to 2009. Moreover, firm’s unobservable characteristics as well as individual unobservable characteristics are correlates with the executives’ equity incentives and their effects should be properly accounted for.

3.5.2 Effect of Equity Incentives on Firm Performance - Dynamic Panel Specifications

This section discusses the results of dynamic panel specifications in order to analyze the effect of equity incentives on firm performance accounting for the time dependence of firm performance. As discussed before, firm performance is suspected to be autoregressive. The regression residuals obtained from static panel models are confirmed to be serial correlated, which justifies the use of dynamic panel settings. In dynamic panel setting, firm performance from last period is also included as a deciding factor of current firm performance. Both difference GMM and system GMM are applied to consistently estimate the parameters.

Table 3.6A presents the estimation results using difference GMM. The second column and third column show that firms’ performance of last period has a positive effect on their current performance, in 1992-2005 subsample. This indicates that the momentum effect of firm performance exists, i.e. good firms tend to perform well, at least in the near future. The inverted U-shaped relations between executives’ option awards and firm performance shown in static panel specifications stay robust in dynamic panel setting. The turning points are located around 5 billion USD, which are too large to be realistic. The amounts of stock awards executives received show a weak negative effect on firm performance, but this effect is not robust to inclusion of firms' other observable characteristics in the regression. To avoid the case that the second lag of firm performance is correlated with the differenced error term to some extent, I also carry out the estimation using the third lag and earlier lags of variables as instruments. The results confirm the positive time dependence of firm performance, and the concave relation between option awards and firm performance. The positive effect of firm performance from last period remains to be statistically significant in 2006-2009 subsample, but no effect of equity incentives on firm performance could be confirmed.

As mentioned in Section 3, I also test the assumptions on error term distribution. If the error terms are independently distributed, which is a vital assumption for the consistency of difference GMM, then the differenced error terms would follow an MA(1) process. The test results confirm this hypothesis (more precisely, the tests reject the null hypothesis that the differenced error terms do not follow an MA(1) process). The test results provide no evidence that the differenced error terms follow an MA(2) process. In one word, the error terms behave as assumed. The results of Wald test to check the joint significance of the stock awards variables and option awards variables show that these equity incentives are correlated with firm performance from 1992 to 2005, but not significant from 2006 to 2009.

To check the validity of the exploited moment conditions, the results of two J tests for over-identifying restrictions are also reported. Sargan test is robust to many instruments used, while Hansen test is robust to the distribution of error terms. The results of Hansen tests show that there are certain invalid restrictions used. But the results of Sargan tests for the specification including many observable firm characteristics fail to reject the null hypothesis that the moment restrictions are invalid.

System GMM is perceived as a more efficient extension of difference GMM by including more moment conditions and exploiting more information from the data. The results of system GMM estimations are reported in Table 3.6B. The results confirm the evidence provided using difference GMM identification strategy. The error terms behave as assumed, and the results of Wald tests support the joint significance of equity incentives in 1992-2005 subsample but not in 2006-2009 subsample. But the results of Sargan test and Hansen test reject the validity of the exploited moment restrictions. Therefore the results from system GMM should be used cautiously.

In summary, when the firms' performance from last period is also included in the analyses, a positive time dependency in firm performance is found. Inverted U-shaped relation between the amounts of option awards and firm performance is also located, with unrealistically large turning points. Therefore only the left parts of the inverse U shapes are relevant and the relations are effectively concave and positive. Intuitively, firm performance is increasing with executives' option awards at decreasing rates.

Given that some evidence is shown in static panel setting when analyzing the effect of equity incentives from last period on firm performance, I also study this relation in dynamic panel setting, by adding lagged firm performance in the set of regressors. The results are presented in Table 3.7A - Table 3.7B located in the Appendix. In general, the equity incentives executives received from last period are shown to have no impact on firms' current performance.

TABLE 3.6A Effects of Equity Incentives on Firm Performance in Dynamic Panel Setting – Firm & Individual Fixed Effects (using Difference GMM)

Variable	1992-2005 Sample (Diff. GMM with 2 lags)		1992-2005 Sample (Diff. GMM with 3 lags)		2006-2009 Sample (Diff. GMM with 2 lags)	
lag Q	0.153***	0.181***	0.195***	0.201	1.345***	1.046***
	(0.042)	(0.056)	(0.061)	(0.134)	(0.184)	(0.315)
Stocks	-0.271*	-0.165	-0.191	-0.179	0.145	0.160
	(0.150)	(0.143)	(0.121)	(0.145)	(0.186)	(0.217)
Stocks^2	2.1E^{-05}	9.1E^{-06}	2.3E^{-05}	3.8E^{-05}	-2.1E^{-04}	-8.2E^{-04}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Options	0.086***	0.079***	0.076***	0.060***	0.039	0.061
	(0.024)	(0.021)	(0.023)	(0.019)	(0.033)	(0.047)
Options^2	-7.8E^{-06}**	-8.2E^{-06}*	-7.3E^{-06}**	-7.3E^{-06}*	-1.3E^{-04}	-2.2E^{-04}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-2.896		-12.429***		-9.920
		(3.110)		(3.833)		(9.583)
LN(S)^2		-0.028		0.800**		0.704
		(0.301)		(0.341)		(0.728)
K/S		-1.130		-1.214		-2.088
		(1.246)		(1.078)		(4.069)
(K/S)^2		-0.003		-0.001		0.162
		(0.015)		(0.013)		(0.446)
Sigma		0.015		0.030		-0.045
		(0.017)		(0.018)		(0.087)
Sig_dum		-2.376		-2.764*		2.039
		(1.652)		(1.448)		(3.453)
Y/S		-0.103		0.057		0.367
		(0.126)		(0.094)		(0.759)
(R&D)/K		0.079		0.064		0.300
		(0.083)		(0.075)		(0.522)
R&D_dum		-0.910		3.138		1.860

		(4.379)		(6.810)		(3.221)
A/K		3.576		5.183		-1.777
		(2.983)		(3.471)		(1.548)
A_dum		-1.503		-2.411		2.503
		(2.201)		(2.593)		(2.111)
I/K		-2.673		-2.180		-13.168*
		(2.437)		(4.049)		(7.285)
Wald	14.68	15.29	13.14	10.07	3.02	2.45
p-Wald	0.01	0.00	0.01	0.04	0.56	0.65
p-Sargan	0.01	0.76	0.02	0.96	0.00	0.09
p-Hansen	0.00	0.00	0.00	0.07	0.33	0.84
p-MA(1)	0.00	0.00	0.00	0.00	0.01	0.12
p-MA(2)	0.64	0.59	0.60	0.39	0.44	0.69

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported.

*, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

Wald-test results are used to test the joint significance of the four equity incentive variables, and p-value (Wald) reported are the corresponding significant levels.

'p-Sagan' and 'p-Hansen' report the p-value of the tests for over-identifying restrictions. A rejection of the null in these tests means that the instruments are not exclusively affecting the outcome of interest though the endogenous variable.

'p-MA(1)' and 'p-MA(2)' report the p-value of the tests for first order and second order serial correlation, respectively. 'p-MA(1)' reports the probability of the test statistics show the differenced error terms follow an MA(1) process, when the true process is not. 'p-MA(2)' is interpreted analogously.

TABLE 3.6B Effects of Equity Incentives on Firm Performance in Dynamic Panel Setting – Firm & Individual Fixed Effects (using System GMM)

Variable	1992-2005 Sample (Sys. GMM with 2 lags)		1992-2005 Sample (Sys. GMM with 3 lags)		2006-2009 Sample (Sys. GMM with 2 lags)	
lag Q	0.209***	0.145***	0.045	0.124	1.843***	0.757***
	(0.039)	(0.043)	(0.073)	(0.120)	0.134	0.269
Stocks	-0.057	0.139	0.079	-0.079	-0.646	0.083
	(0.116)	(0.138)	(0.107)	(0.125)	(0.500)	(0.197)
Stocks^2	-1.2E^{-05}	-5.2E^{-05}	-2.7E^{-05}	1.2E^{-05}	1.7E^{-03}	-5.6E^{-04}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Options	0.084***	0.081***	0.087***	0.072***	0.063	0.075*
	(0.019)	(0.020)	(0.023)	(0.017)	(0.042)	(0.040)
Options^2	-7.8E^{-06} **	-7.2E^{-06} **	-6.8E^{-06} ***	-7.3E^{-06} **	-6.2E^{-05}	-2.1E^{-04}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-4.168***		-5.293***		-17.021***
		(1.246)		(1.921)		(3.251)
LN(S)^2		0.243*		0.357**		1.025***
		(0.101)		(0.143)		(0.241)
K/S		-2.803***		-1.177		-5.620
		(1.024)		(0.927)		(3.795)
(K/S)^2		0.015		-0.001		0.366
		(0.010)		(0.010)		(0.467)
Sigma		0.018		0.027		-0.105
		(0.015)		(0.022)		(0.071)
Sig_dum		-1.399		-1.780		3.746
		(1.293)		(1.848)		(2.541)
Y/S		-0.143		-0.068		1.304*
		(0.154)		(0.111)		(0.732)

(R&D)/K		0.039		0.048		-0.202
		(0.067)		(0.060)		(0.417)
R&D_dum		-1.677		-2.805*		-5.127*
		(1.182)		(1.451)		(2.988)
A/K		1.871		7.209**		-0.357
		(1.399)		(3.449)		(0.988)
A_dum		-0.657		-5.181***		3.710*
		(1.163)		(1.279)		(2.044)
I/K		-0.666		0.189		-9.770*
		(1.733)		(3.039)		(5.583)
Wald	19.19	22.70	17.96	18.50	2.99	4.14
p-Wald	0.00	0.00	0.00	0.00	0.56	0.39
p-Sargan	0.00	0.00	0.00	0.16	0.00	0.05
p-Hansen	0.00	0.00	0.00	0.04	0.05	0.74
p-MA(1)	0.00	0.00	0.04	0.00	0.00	0.04
p-MA(2)	0.17	0.06	0.15	0.81	0.19	0.86

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported.

*, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

Wald-test results are used to test the joint significance of the four equity incentive variables, and p-value (Wald) reported are the corresponding significant levels.

'p-Sagan' and 'p-Hansen' report the p-value of the tests for over-identifying restrictions. A rejection of the null in these tests means that the instruments are not exclusively affecting the outcome of interest though the endogenous variable.

'p-MA(1)' and 'p-MA(2)' report the p-value of the tests for first order and second order serial correlation, respectively. 'p-MA(1)' reports the probability of the test statistics show the differenced error terms follow an MA(1) process, when the true process is not. 'p-MA(2)' is interpreted analogously.

3.6 Conclusions

The main objective of this chapter is to analyze the effect of equity incentives for top executives on firm performance. To properly identify this relation, static panel as well as dynamic panel specifications are estimated and tested. Non-linearity in equity incentives is also allowed. Some findings worth noting are summarized as follows.

No statistically significant relation is located between the amounts of stock awards for executives and firm performance. An inverted U-shaped relation is found between the use of option awards and firm performance, but since the theoretical optimal points of option awards are too high to be realistic, the relation between the two is basically concavely positive. Intuitively, firm performance increases with the option awards for executives at a decreasing rate, when firm performance is measured as Tobin's Q. Moreover, empirical evidence shows that firm- and individual unobservable characteristics are correlates with the executives' equity incentives and other firm observable characteristics.

Several interesting evidences are found when analyzing the relation between firm performance and the equity incentives rewarded to executives in last period. From 1992 to 2005, the amounts of stock awards and option awards in executive compensations of last year have a concavely positive effect on firm performance this year, while the lagged stock awards has a negative effect on firm performance from 2006 to 2009. Empirical evidence also shows that firm fixed effect as well as individual fixed effect are prominent and should be properly controlled for.

The relations between changes of executives' equity incentives and firm performance are also studied. In both of 1992-2005 subsample and 2006-2009 subsample, empirical evidence show that firm performance is increasing with changes of executives' stock awards at increasing rates. Changes in executives' option awards are found to have positive effect on firm performance from 2006 to 2009. Consistent with previous findings, firm- and individual unobservable characteristics are found to be correlated with the changes in executives' equity incentives and other regressors.

Summarizing the results of dynamic panel specifications, when the firms' performance from last period is also included in the analyses, a positive time dependency in firm performance is found. Inverted U-shaped relation between the amounts of option awards and firm performance is also located, with unrealistically large turning points. Therefore only the left parts of the inverse U shapes are considered relevant and the relations are effectively concave and positive. Intuitively, firm performance is increasing with executives' option awards at decreasing rates.

The effect of equity incentives on firm performance is summarized in Table 3.8. There are several interpretations of the findings. For stock awards, the "no relationship" evidence can be interpreted as the stock awards for executives are near the equilibrium level (all observations are located near the top of the theoretical inverted-U shape), therefore no obvious pattern is shown (the optimal contracting hypothesis). It may also be the case that contemporaneous stock awards are not effective on steering good efforts of executives. For option awards, the concavely positive effect may indicate that executives are under-incentivized, and rewarding them more options can increase firm performance (the optimal contracting hypothesis). Meanwhile, it is equally possible that executives have influences on their own compensations, and reward themselves more compensations after a good year (managerial power hypothesis). They use option awards as the form of excessive rent extraction because option awards are not required to be disclosed before 2006, and are difficult to value. However, which interpretation is more appropriate could not be answered in this study. More sophisticated researches are needed to further study these questions.

TABLE 3.8 Summary of Results

Equity Incentives	Stocks Awards		Options Awards	
Subsample	1992-2005	2006-2009	1992-2005	2006-2009
Static Panel Equity Incentives in level	--	--	Inverted U Shape (Increasing)	Inverted U Shape (Increasing)
Static Panel Equity Incentives in 1st lag	Inverted U Shape (Increasing)	U Shape (Decreasing)	Inverted U Shape (Increasing)	--
Static Panel Equity Incentives in 1st difference	U Shape (Increasing)	U Shape (Increasing)	--	Positive
Dynamic Panel Equity Incentives in level	--	--	Inverted U Shape (Increasing)	--
Dynamic Panel Equity Incentives in 1st lag	--	--	--	--

Source: Compiled by author. Only the relations between equity incentives and firm performance are shown.

Chapter IV:

Determinants of

Executive Compensation Structure

4.1 Introduction

Agency problem is under heated debate after it was raised by Jensen and Meckling (1976). To mitigate this problem, executives were granted firms' shares in order to align executives' interest with those of shareholders (Morck, Shleifer, and Vishny 1988). The use of equity incentives as CEO compensations become popular and increase significantly since 1980.

As a result, issues in executive compensation also attract a lot of attentions in academic communities and business societies. Among others, the question about the effect of equity compensation on firm performance, a research question closely tied to the optimal contracting hypothesis, is under intensive reviewed. There exist many good theoretical as well as empirical researches studying the relation between executive compensations and firm performance. However, most of these studies fail to discuss the dynamics in contracting process, and implicitly assume that executive compensations are exogenous. Bebchuk and Fried (2003) suggest that the designs of executive compensations should not be viewed as only an instrument for mitigating the agency problem, but are also affected by agency problem and managerial power. They argue that powerful executives themselves could have substantial influence over the contracting process. From my point of view, the endless debate between optimal contracting camp and managerial power camp roots in the question that how is executive compensation determined.

The effects of firm- and manager characteristics on the level of executive compensations have been extended studied. However, little is known about the effects of important factors on the compositions of executive compensations, i.e. different forms of compensations as a percentage of total compensation.

As far as I am aware of, two other papers studying this question exist. Ryan and

Wiggins (2001) study the correlations between firm specific and individual specific characteristics and different types of executive compensations in percentage. They report that the use of stock options is positively correlated to market-to-book assets, capital expenditure intensity, and R&D intensity. In addition, they find that the use of cash bonuses is negatively correlated to cash flow volatility, while the use of stock options is positively correlated with cash flow volatility. They also locate a concave relation between cash bonus and CEOs' age, which indicates that firms compensate both the youngest and the oldest executives with less cash bonuses. A similar concave relation is found between the use of restricted stocks and CEOs' age. But their sample is limited, which comprises only 1095 firms in 1997. Graham, Li, and Qiu (2012) sophisticatedly research the effects of firm specific characteristics and individual specific characteristics on executives' compensation. They show that firm size, growth opportunities, and tenure of the executives, being at the CEO position are all positively related to the level of executives' total compensations. But they fail to provide evidence about the determinants of different forms of compensation as a fraction of executives' total compensations, or the structure of executive compensations.

In this chapter, I analyze the effects of personal specific characteristics and firm specific heterogeneity on the compositions of executive compensation, using data of all firms in the S&P 500, the Midcap 400, and the Smallcap 600 from year 2006 to year 2009. Executive compensation data from 2006 are based on SEC's new disclosure rules released in the same year, which requires more detailed and complete disclosure of top executives' compensation compositions. Among other findings, I provide evidence that younger and older executives receive more current compensation but less equity incentives. In addition, CEOs receive more equity incentives and long-term performance bonus than non-CEO executives. For executives in above-average firms in the industry, their compensation packages comprise less current compensation and stock options, but more non-equity incentives. The effects of other personal specific characteristics and firm specific characteristics are shown and discussed in more detail below.

The rest of this chapter is organized as the following. Existing literatures of importance are reviewed in Section 4.2. Section 4.3 introduces the specification strategies used as well as the proxy variables chosen. Section 4.4 provides an overview of the sample and a first glance of data by comparing means of subgroups. Empirical results will be shown and discussed in Section 4.5 and Section 4.6 summarizes.

4.2 Literature Review

Issues in executive compensation have attracted a lot of attentions in academic communities and business societies. Some researchers survey the development of executive compensation structure. The use of stock options as part of CEO compensations has increased significantly since 1980. Hall and Liebman (1998) document that only 30% of CEOs received stock options in their compensation contracts, and the average value of options were less than one fourth of the average value of salary and bonus, in 1980. By 1994, 70% of CEOs received stock options and the average value of options climbed up to the average value of salary and bonus. Core and Guay (1999) show that on average, stock options composed about one half of the CEO's total equity incentives, using the sample of CEOs from 1992 to 1996. Similarly, using CEO compensation data from 1993 to 1998, Core, Guay and Verrecchia (2000) document that the value of stock options and restricted stocks comprised about one third of CEOs' total compensation package on average. Hall and Murphy (2002) report that in 1998, the value of stock options and restricted stocks held by S&P Industrial CEOs was $30 million, and that of S&P Financial CEOs was $55 million, on average. These values are significantly larger than the amount of salary and bonus in the CEOs' compensation. Bebchuk and Fried (2003) report an inverse relation between CEO incentive compensation and firm size, and they argue that this can be explained by CEO entrenchment.

In the view of optimal contracting hypothesis, the changes in executive compensation structure over time are believed to be driven by the firms' attempts on aligning top executives' interests with shareholders' interests. Firms are trying to incentivize their executives most efficiently, but there is no static compensation combination which fits all firms and all executives. The optimal compensation structure, if exists, depends on firm specific characteristics as well as manager individual heterogeneities. Meanwhile, the supporters of managerial power hypothesis (such as Bebchuk, Fried, and Walker (2002)) allege that the self-interested executives are influential in the boards and hence can decide their own compensations. The actions of the entrenched executives will also affect the firm's other financial variables.

As the original purpose of rewarding executive with different forms of compensations is interest alignment and steering good efforts, many researchers focus on relating the use equity incentives and firm performance. Mehran (1995) study the executive compensation structures of 153 firm using data from 1979 to 1980, and find a positive relation between managerial stock holdings and firm performance, using Tobin's Q and return on assets as performance proxies. In addition, the percentage of equity incentives in executive total compensation is also found to be positively related to firm performance. Conyon (1997) studies this relation using data from 213 large UK companies between 1988 and 1993. He reports that the compensations of firms' directors are positively related to firm performance, which is measured as shareholder returns. Garen (1994) analyzes the determinants of the level and structure of executive compensation using Jensen and Murphy (1990)'s data from 430 large companies' proxy statements in 1987. He presents evidence showing that for firms with more variable profitability, the correlation between executives' equity-based compensations and firm performance is lower.

Except for performance, firm size is the most obvious factor in determining optimal contracting. Frydman and Saks (2010) test the correlation between total compensation amounts and firm size for the largest fifty firms in the year from 1936 to 2005, and show that the correlation became more significant recently. For the period from 1976 to 2005, they estimate the coefficient to be lying in the range of 0.29 - 0.36, which is close to the estimates of Jensen and Murphy (1990). Murphy (1985) reports that large firms tend to pay their executives more than smaller firms, and the growth of firm sales is strongly related to the level of executive compensation. Core and Guay (1999) try to model optimal equity incentive levels for

CEOs, and show that CEOs' equity incentives are positively related to market value of equity. They also find that CEOs' equity incentives increase with CEOs' tenure. Gabaix and Landier (2008) further argue that due to the competition for high ability executives, which leads to higher equilibrium in executive compensation, executives' level total pay should increase with firm size.

The effects of other firm characteristics, such as capital structure, industry group, growth opportunities, on executive compensation are also studied. Kole (1997) analyzes the compensation contracts of 371 of the Fortune 500 firms in 1980 and shows that compensations contracts vary significantly due to different mixtures of tangible and intangible assets in the firms. He also shows that more research-intensive firms offer more equity-based awards. Murphy (1999) documents that stock options compose smaller portions of the compensation packages for CEOs in utility industry, compared to those of CEOs in other industries. Ittner, Lambert, and Larcker (2003) report that high-technology firms offer significantly more stock options than manufacturing firms to compensate and incentivize their CEOs. John and John (1993) show that firms with higher debt-to-equity ratio use less stock options in the CEOs' compensation packages. Bryan, Hwang, and Lilien (2000) also document a negative relation between the portion of debt in firms and the usage of stocks options as CEOs' incentives. Smith and Watts (1992) find that the use of stock options and restricted stocks is positively related to firms' growth opportunities. They claim that equity compensations provide top executives incentives to increase stockholder value, and hence lower monitoring costs and mitigates agency problem.

Variations in manager individual characteristics also influence executive compensations. Core and Guay (1999) find that CEOs' equity incentives increase with CEOs' tenure. Among top executives in firms, the compensation package compositions for CEOs differ from those for non-CEO executives. Evidence shows that equity-based incentives have higher weights in CEOs' total annual compensation. Core and Larcker (2001) show that compared to non-CEO executives, the ratios of stock options to base salary are higher for CEOs. Ittner, Larcker, and Rajan (1997) provide similar insights. They argue that local measures of performance are more important in providing incentives to non-CEO executives. Moreover, as they are not yet on top of the organizations, non-CEO executives also have the implicit incentives of being promoted. Assuming exogenous firm size, Baker and Hall (2004) argue that much of the cross sectional variations in CEOs' incentive compensations can be attributed to individual heterogeneities in CEOs' ability, or productivity.

Among these enormous researches in determinants of executive compensation, only a few properly take into account the effects of both firm specific characteristics and individual specific characteristics. Ryan and Wiggins (2001) study the correlations between the different types of executive compensations and firm specific and individual specific characteristics, using a sample of CEOs of 1095 firms in 1997. They show that the use of stock options is positively correlated to market-to-book assets, capital expenditure intensity, and R&D intensity. In addition, they find that the use of cash bonuses is negatively correlated to cash flow volatility, while the use of stock options is positively correlated with cash flow volatility. In terms of individual specific characteristics of CEOs, they report a concave relation between cash bonus and CEOs' age, where firms compensate both the youngest and the oldest executives with less cash bonuses. A similar concave relation is found between the use of restricted stocks and CEOs' age.

A more recent study by Graham, Li, and Qiu (2012) sophisticatedly researches the effects of firm specific characteristics and individual specific characteristics on executives' compensation structures. They use data from 1992 to 2006, basing on the firms' proxy statements. They show that firm size, growth opportunities, and tenure of the executives, being at the CEO position are all positively related to the level of executives' total compensations. In addition, they control for the firms' unobservable characteristics as well as executives individual heterogeneities. The positive effects of firm size, growth opportunities, tenure of the executives, and CEO position to executive total compensation remain significant, but the magnitudes are much smaller. They also find that firm specific characteristics and individual specific characteristics are significant factors in determining the level of executive compensation, with individual specific characteristics being the more important one.

4.3 Model Specifications

As shown in the aforementioned researches, executive compensations depend not only on observable firm characteristics, such as firm size (Murphy (1985), Core and Guay (1999), Gabaix and Landier (2008), Frydman and Saks (2010), etc.), R&D intensity (Kole (1997), Ryan and Wiggins (2001)), growth opportunity (Smith and Watts (1992), Core and Guay (1999)), but also on executives' personal characteristics such as age (Core and Guay (1999), Ryan and Wiggins (2001)) and position (Ittner, Larcker, and Rajan (1997), Core and Larcker (2001), Baker and Hall (2004)). In addition to these observable characteristics, some other unobservable factors may also have impacts on executive compensations.

The most influential firm unobservable characteristic is corporate governance quality. A firm with better corporate governance system can monitor executives' action with lower cost and hence, as one may conjecture, provides less equity incentives in executives' compensation package. On the other hand, if the firm's corporate governance is loose and difficult to monitor top executives' decision process, the firm will probably offer more equity incentives to align the executives' personal interest to that of the other shareholders. Unfortunately, a firm's corporate governance system is neither directly observable nor easily measurable. Empirical researches try to measure it or control for it with different proxy variables, but no single variable is generally accepted as the most proper proxy of corporate governance quality in the academic society, though it is of utmost importance in deciding executive compensation. Therefore, firm unobservable characteristics need to be controlled properly.

Executives' personal unobservable characteristics are essential in determining the structures of the compensation packages they receive. One good example is the ability, or productivity, of the executives. An executive with a reputation of having high ability is expected to receive higher salary and cash bonus, because many firms are competing to hire him and attempt to attract him with high fixed payment and low risk sharing. On the other hand, a manager with low productivity will have less fixed payment but more restricted stocks and stock options. It is believed that good financial performance for the firms with less productive executives are partly due to pure luck. Hence low quality managers will be compensated with more equity incentives, or in other words, will share more risk with the firm. Executives' productivities are not observable but affecting executive compensation. These effects also need to be controlled in a sophisticated study.

Although technical difficulty exists in estimating the effects of unobservable firm specific characteristics and executive personal latent characteristics, these attributes can be assumed to be fixed. Firms' corporate governance quality for example, may not change in a short period, or only change slowly over time, if it changes. Executives' ability and personality can also be assumed to be stable over short period of time. These are not harsh assumptions, and with the help of these assumptions unobservable firm specific characteristics and unobservable executive personal characteristics can be controlled properly using the fixed effect design in panel data models.

Ryan and Wiggins (2001) and Graham, Li, and Qiu (2012) use the fixed effect design in their studies on executive compensations. Graham, Li, and Qiu (2012) emphasize the importance and necessity of including firm fixed effects and individual fixed effects in the estimations. They show that unobservable firm specific characteristics and unobservable executive personal characteristics have great explanation power on the variation of executive compensations. As an evidence of bias in OLS estimates, they show that the magnitudes of the estimated coefficients for explanatory variables differ significantly with and without controlling firm fixed effects and individual fixed effects.

4.3.1 Empirical Method

The main objective of this chapter is to analyze the determinants of executive compensation structure. Let's assume the executive compensation structure is affected by firm- and manager characteristics in the following form (Equation (4.1)).

$$ECC_{it} = \beta_0 + \beta_1 ' \ PerChar_{it} + \beta_2 ' \ FirmChar_{it} + u_i + e_{it} \tag{4.1}$$

ECC_{it} represents percentage of executive compensation component, for manager i in time t. ECC will be the percentage of salary + bonus, the percentage of restricted stocks, the percentage of stock options, and the percentage of non-equity incentives as a fraction of total compensation. $PerChar_{it}$ is a vector of executives' observable characteristics, and $FirmChar_{it}$ is a vector of firms' observable characteristics. The choice of proxy variables for executives' observable characteristics and firms' observable characteristics will be described in the following section. u_i is a scalar summarizing the unobservable time-invariant characteristics (or the fixed effect), and e_{it} is the error term.

As discussed in the last section, the unobservable executive specific characteristics and firm specific characteristics probably have an impact on the explained variable, ECC. If this is true, omitting them will lead to the omitted variable problem and the parameters estimated from OLS would be biased. As the unobservable fixed effects are not time varying, they can be cancelled out by demeaning the whole equation, as illustrated below.

$$\overline{ECC_i} = \beta_0 + \beta_1 ' \ \overline{PerChar_i} + \beta_2 ' \ \overline{FirmChar_i} + \overline{u_i} + \overline{e_i} \tag{4.2}$$

$$\begin{aligned} ECC_{it} - \overline{ECC_i} &= \beta_1 ' \ (PerChar_{it} - \overline{PerChar_i}) \\ &+ \beta_2 ' \ (FirmChar_{it} - \overline{FirmChar_i}) + (u_i - \overline{u_i}) + (e_{it} - \overline{e_i}) \end{aligned} \tag{4.3}$$

First I sum up all variables overtime and calculate the overtime-mean values for every variable in each group (Equation (4.2)). Then I demean all variables by deducting Equation (4.2) from Equation (4.1) (and get Equation (4.3)). Since the unobservable fixed characteristics are time-invariant, the overtime average values equal to the corresponding level values. Then Equation (4.3) is reduced to Equation (4.4).

$$
\begin{aligned}
ECC_{it} - \overline{ECC_i} = \beta_1{}' \; (PerChar_{it} - \overline{PerChar_i}) \\
+\beta_2{}' \; (FirmChar_{it} - \overline{FirmChar_i}) + (e_{it} - \overline{e_i})
\end{aligned}
\qquad (4.4)
$$

After this demeaning process the unobservable fixed effects are cancelled out and the OLS estimation for Equation (4.4) is unbiased.

This fixed effect model is widely used in researches with panel data setting. Its application in this study is appropriate if Equation (4.1) is a good approximate of the true relationship between executive compensation components and other variables. The assumption on firm- and manager unobservable heterogeneity, u_i, decides which estimator is appropriate. If u_i is assumed to be randomly decided and not related to other regressors, then OLS estimator is consistent and GLS estimator is consistent and efficient[22]. But it is an extremely strict assumption in modern business world, since almost every variable is related with the others, especially for the important variables such as corporate governance quality or executive ability. The fixed effect estimators, on the other hand, only require a mild assumption that the firm- and manager unobservable heterogeneity is time-invariant, which is usually fulfilled. In the coming sections, I will also carry out some tests to check the validity of applying fixed effect estimators in this study.

However, the application of fixed effect estimators has a major drawback. To cancel out the unobservable effects, a demeaning process is carried out as shown above.

[22] See, for example, Chapter 9 of Greene (2008), Chapter 10 of Woodridge (2002).

After this process, only the within group variations are left for estimating the parameters. If the executive compensation components and other firm observable characteristics, manager observable attributes also vary slowly overtime, the left-over variations may be too small to have stable parameter estimates. This potential problem could be solved by including data from longer periods. Also, as will be shown in later part of this study, the explained variables and all of the explanatory variables vary overtime. Therefore this theoretical drawback is not a main concern in this chapter.

4.3.2 Measurements of Compensation Structure

The compensation plans of the top executives of the firms are composed of different types of remuneration. Each type of compensation has a different objective. For example, base salary, which is not related to executive's performance, is mainly used by firms to compete for good managers. As managers are normally assumed to be rational and risk averse, riskless payoff is an important factor for attracting and keeping good managers. Among other kinds of compensations, bonus is used to compensate for short term performance, while restricted stocks and stock options are used to compensate for long run performance. The amendments SEC released in 2006 required detailed and complete disclosure of top executives' compensation compositions. The components of executives' total compensation are categorized into the following seven groups.

Base Salary

Base salary is the fixed portion of the executives' compensation plans. The amounts are decided a priori and are independent of the executives' performance. This riskless part of compensation is used by firms to attract and keep executives with high abilities. As the risks and competition intensities differ in different industries, significant heterogeneity exists in the amount of base salary as well as the ratio of base salary as a fraction of total compensation for executives in different firms. Other firm characteristics such as size and growth opportunities are also important factor for the variation in base salaries.

Bonus

Bonus payment is a compensation type which is used as a reward for single-year's performance and backward-looking. It is always grouped with base salary in academic researches as current compensation. This practice is not unjustified. Base salary is independent of performance, but the amount of base salary will have a direct effect on the amount of bonus payment. This argument becomes obvious when we look at the income statements of the firms. When the base salary of executives is higher, the management cost of the firm is consequently higher, which leads to lower accounting revenue, keeping other factors unchanged. The portion of revenue which can be paid out as bonus payments is therefore smaller. Hence, as base salary and bonus payment are co-determined, I will sum up these two items as current compensation in the empirical studies of this chapter.

Stock Awards

This category includes all kinds of stock-related awards, such as restricted stocks, phantom stocks, common stock equivalent units etc. The value is calculated in accordance to the valuation rules of shares as described in FAS123R.

Restricted stocks dominate in this compensation type. The stocks are restricted as the executives are contracted to hold certain numbers of firm's share as long as they are at certain positions. In other words, these shares are forced to be forfeited under conditions such as leaving the company. The values of restricted stocks are directly linked to the companies' future performance, and the payoffs of restricted stocks are symmetric and forward-looking. Because of these attractive features, restricted stocks are the primary instrument the firms use to align the interest of executives to shareholders' interest. Kole (1997) shows that restricted stock plans are more common in R&D-intensive firms than in non-R&D firms, and the average vesting period for restricted stock grants are also longer for R&D-intensive firms than for non-R&D firms. This chapter will further study which firm characteristics and executive individual characteristics have impacts on the use of stock awards.

Option Awards

This category covers all instruments with option-like features, such as stock options and stock appreciation rights. The valuation process is also based on FAS123R as required by the SEC.

Stock options give the executives the rights to buy the firm's share at a pre-determined price in the future. These compensations incentivize the executives to concentrate on firms' future performance when making decisions. A common practice in academic researches is to group option awards with stock awards as equity incentives (e.g. Core and Larcker (2001), Ittner, Lambert, and Larcker (2001)). However, option awards differ from stock awards in certain important aspects. Firstly, unlike stocks, the payoffs of stock options are asymmetric. The options are valuable to the executives only when the firm's stock price rises higher than the pre-determined exercise price of the options. In other words, when the firm's stock price is too low, the payoff of options is zero. This asymmetry gives the executives incentives to invest in risky projects, in an attempt to boost up the stock price substantially, to make the options valuable and profit from them. Therefore, compensating executives with out-of-money stock options may increase the risk of the firm. Secondly, even when the stock options are in-the-money, their payoffs still differ from the payoffs of common shares, considering the fact that holding stock options are not receiving dividends as holding shares. Due to these differences, I will separately analyze the determinants of option awards and those of stock rewards in this chapter.

Non-Equity Incentives

Non-equity incentives are a type of cash payments which focus on long-term performance, usually based on three-year or five-year horizons' cumulative performance. They are paid to the executives when certain performance thresholds, which are commonly future oriented, are met. They can be seen as "long run bonus", in the sense that they are cash payments when the performance criteria were satisfied. Non-equity incentives are used to balance short-term financial performance and long-term growth trend. By compensating executives with non-equity incentives, the problem of over-risk-taking decision induced by equity incentives can be avoided. To my knowledge, this is the first empirical study analyzing the determinants of non-equity incentives as a part of executives' total compensation.

Pension Changes

This category of compensation is reported following the SEC's retirement plan and post-employment disclosure rules. Compensations in this form are mainly composed of preferential earnings from deferred compensation plans and aggregate increase in actual value of defined benefit and actual pension plans during the year. The changes in value of pension plan are usually pre-determined and not related to executives' individual performance, as long as the firm is not financially stressed.

Other Compensations

Other compensations received by the executives include perquisites and other personal benefits, termination or change-in-control payments, contributions to defined contribution plans (e.g. 401K plans), life insurance premiums, gross-ups and other tax reimbursements, discounted share purchases and so on. This is a coverall category including all compensations which could not be booked into the main categories mentioned above.

These aforementioned types of compensations have different strength and weakness, and consequently used for different objectives. The structures of compensation for executives in different industries, in firms with different level of growth focus vary from each other. In this chapter, the effects of firm specific characteristics and manager individual characteristics on the amounts of different compensations as fractions of total compensation are carefully analyzed. Among these categories, I focus on current compensation (which is the aggregate amount of base salary and cash bonus), stock awards, option awards, and non-equity incentives. The changes of pension plan value are more attributed to regulation reasons than incentivizing executives or aligning their interests with shareholders' interests. Other compensations include all miscellaneous compensation items and by definition are too diverse in nature to have meaningful cross sectional comparison. Therefore pension changes and other compensations are not included in the analyses of determinants. Descriptive statistics in the coming section show that these two types of compensations constitute relatively small portions compared to other compensation forms. This evidence, to some extent, justifies the practice of not including them in further analyses. I summarize the executive compensation variables in Table 4.1A.

TABLE 4.1A Variable descriptions – Executive Compensations

Variable	Description
Salary	The dollar value of the base salary earned by the named executive officer during the fiscal year. Units: Thousands
Bonus	The dollar value of a bonus earned by the named executive officer during the fiscal year. Units: Thousands
Stock Awards	Value of stock-related awards (e.g. restricted stock, restricted stock units, phantom stock, phantom stock units, common stock equivalent units etc.) that do not have option-like features. Valuation is based upon the value of shares that vested during the year as detailed in FAS123R. The amount here is the cost recorded by the company on its income statement as well as any amounts that were capitalized on the balance sheet for the fiscal year. This column discloses the cost that was charged to the company (and thus to shareholders) for the year, as distinct from the grant date fair value of the award. Units: Thousands
Option Awards	Value of option-related awards (e.g. options, stock appreciation rights, and other instruments with option-like features). Valuation is based upon the value of options that vested during the year as detailed in FAS123R. The amount here is the cost recorded by the company on its income statement as well as any amounts that were capitalized on the balance sheet for the fiscal year. This column discloses the cost that was charged to the company (and thus to shareholders) for the year, as distinct from the grant date fair value of the award. Units: Thousands
Non-Equity Incentives	Value of amounts earned during the year pursuant to non-equity incentive plans. The amount is disclosed in the year that the performance criteria were satisfied and the compensation was earned. Units: Thousands
Pension Change	Composed of a) above-market or preferential earnings from deferred compensation plans; b) aggregate increase in actual value of defined benefit and actual pension plans during the year. Units: Thousands
Other Compensation	Other compensation received by the executive including perquisites and other personal benefits, termination or change-in-control payments, contributions to defined contribution plans (e.g. 401K plans), life insurance premiums, gross-ups and other tax reimbursements, discounted share purchases etc. Units: Thousands
Total Compensation	Total compensation as-reported in SEC filings. This is the sum of the above seven categories. Units: Thousands

Data Source: ExecuComp, including definitions of variables.

TABLE 4.1B Variable descriptions – Executive Individual Characteristics and Corporate Financial Variables

Variable	Description
Executive Individual Characteristics	
Age	The age of the executive officer in the recorded year
Gender	The gender of the executive officer
PhD	A dummy variable equal to unity when the executive has a doctoral degree, otherwise zero
CEO	A dummy variable equal to unity when the executive serves as the CEO in the recorded year, otherwise equal to zero
Corporate Financial Variables	
Ind.Bench.	A dummy variable equal to unity if the firm over-performs the industry average, otherwise zero
Tot.Bench.	A dummy variable equal to unity if the firm over-performs the total average, otherwise zero
LN(S)	The natural log of sales, used to measure firm size
$(LN(S))^2$	The square of LN(S), included to allow for nonlinearities in LN(S)
K/S	The ratio of tangible, long-term assets (property, plant, and equipment) to sales, used to measure the alleviation of agency problems due to the fact that such assets are easily monitored and provide good collateral
$(K/S)^2$	The square of K/S, included to allow for nonlinearities in K/S
Leverage	The ratio of book value of liabilities to book value of assets, used to measure the pressure from debt holders
Sigma	The standard deviation of idiosyncratic stock price risk, directly extracted from Compustat
Sig_dum	A dummy variable equal to unity if the data required to estimated SIGMA is available, and otherwise equal to zero (if SIGMA is missing). To maintain sample size, I set missing observations of SIGMA equal to zero, and then include this dummy variable to allow the intercept term to capture the mean of the SIGMA for missing values
Y/S	The ratio of operating income to sales, used to proxy for market power of cash flows and measure the gross cash flows available from operations
(R&D)/K	The ratio of research and development expenditures to the stock property, plant, and equipment, used to measure the role of 'R&D capital' relative to fixed capital
R&D_dum	A dummy variable equal to unity if R&D data were available, otherwise equal to zero
A/K	The ratio of advertising expenditures to the stock of property, plant, and equipment, used to measure the role of 'advertising capital' relative to fixed capital
A_dum	A dummy variable equal to unity if advertisement data were available, otherwise equal to zero
I/K	The ratio of capital expenditures to the stock of property, plant, and equipment

Data Source: Executive Individual Characteristics variables are extracted from ExecuComp; Corporate Financial variables are extracted from Compstat. Several definitions of Corporate Financial variables are from Himmelberg et.al (1999).

4.3.3 Proxy Variables for Firm- and Executive Characteristics

In this section, I describe the firms' observable characteristics and the managers' observable characteristics chosen for analysis, i.e. the variables included in vector $PerChar_{it}$ and vector $FirmChar_{it}$. The descriptions of the proxy variables for executive individual characteristics and corporate financial characteristics are summarized in Table 4.1B.

Age

Age is the most conveniently measured manager individual observable characteristics, and it is also of great importance. For most executives, except for those who have been working as researchers for certain years, age is a good proxy for work experience. The a priori prediction for the relation between executives' age and their compensation structure is under debate. Core and Guay (1999) find that CEOs' equity incentives increase with CEOs' tenure. Ryan and Wiggins (2001) argue that younger executives strive to build up reputation in a short period (Gibbons and Murphy (1993)), while older executives want to have better performance before retirement (Hirshleifer (1993)). Hence both groups have incentives to focus on shorter term goal than middle-aged group of executives. They also argue that an executive working for the same firm will accumulate more experience, but on the other hand, he is also more likely to be entrenched. They provide evidence showing that both the cash bonus and restricted stocks are concavely related to CEOs' age. Their findings suggest that firms compensate both the youngest and the oldest executives with less cash bonuses and less restricted stocks. However, according to the predictions that both younger and older executives are focusing on short run performance, current compensations should constitute larger portions in their compensation plans, to avoid over-risky behaviors. In this chapter I also include age and its second order term to estimate the potential non-linear relation. I did not include tenure, the number of years the executives have been working for their current companies, because only one third of the observations in my current sample have information in tenure. In order to maintain the sample size, I have to leave out tenure and implicitly assume that it is strongly related to age, or its effect on executive compensation structure is analogous.

Being the CEO

Among top executives in firms, the compensation package compositions for CEOs differ from those for non-CEO executives. A common and obvious expectation is that the total compensation amounts for CEOs are significantly higher than those of non-CEOs. But the differences in compensation structure, i.e. the amounts of different categories of compensations as a fraction of total compensation, are not clear. Empirical evidence shows that equity-based incentives have higher weights in CEOs' total annual compensation. Core and Larcker (2001) show that the ratio of stock options to base salary is higher for CEOs than that of non-CEO executives. Ittner, Larcker, and Rajan (1997) provide similar insights. They argue that local measures of performance are more important in providing incentives to non-CEO executives. Moreover, as they are not yet on top of the organizations, non-CEO executives also have the implicit incentives of being promoted. Assuming exogenous firm size, Baker and Hall (2004) argue that much of the cross sectional variations in CEOs' incentive compensations can be attributed to individual heterogeneities in CEOs' ability, or productivity. To study the differences in compensation structure between CEOs and non-CEO executives, I include a dummy variable indicating whether the executive is currently positioned as CEO in the analyses.

Gender

Wage differences between female workers and male workers are widely researched in labor economics literatures and gender studies. Most empirical evidences show that wages of female are lower than those of comparable male workers (e.g. Stanley and Jarrell (1998)). Results from Graham, Li, and Qiu (2012) confirm that assuming all other attributes are equivalent, the amounts of total compensation for female executives are lower than those for male executives, and the difference is statistically significant. But they fail to offer further evidence on the structural differences between the compensation packages for the two groups of executives. I include a gender dummy in all analyses to check whether such differences exist.

PhD Degree

Another issue under debate in labor economics literatures is the problem of "over education", firstly raised in Richard Freeman's "The Overeducated American" in 1976. It is widely accepted in the field of labor economics that there exist an inverted U-shaped relation between years of schooling and wages, in other words, wage first increases with years of education and then starts decreasing after the years reach the point of 16 (e.g. Rumberger (1987)), which is the common number of years needed to get a Master degree starting from elementary school. To my knowledge, whether this over education effect exists in executives' total compensation is not yet studied. Since there is no data on number of years of schooling or the educational degrees of executives exist in my dataset, I will try to answer this question by studying whether a difference exists in the amounts and compositions of total compensation for executives with a PhD degree and those for executives without a PhD degree. I assume that most executives without a doctoral degree will have a master degree, probably an MBA degree, which is of great popularity in the business society and of great importance for professional managers. By comparing the amounts of total compensation of these two groups, combined with the assumption that the other characteristics are similar[23], the question of whether over education problem exists in executives might be answered. In addition, I include a dummy

[23] This assumption is unrealistic, therefore the comparison on total amounts is merely tentative.

indicating whether the executives have a doctoral degree in all analyses, in order to scrutinize the effect of a PhD degree in executives' compensation structures.

Relative Performance

As the original purpose of rewarding executives with different forms of compensation is interest alignment and steering good efforts, one crucial determinant of compensation is firm performance. Mehran (1995) shows that both managerial stock holdings and the percentage of equity incentives in executive total compensation are positively related to firm performance. Conyon (1997) also reports that the compensations of firms' directors are positively related to shareholder returns.

Firm performance should be included in the analysis with cautions. Widely used firm performance proxies, including market measures such as Tobin's Q and stock returns, and accounting measures such as return on assets and return on equity are expected to be strongly correlated with firm's other financial fundamentals. Directly including such firm performance variables in the analysis may lead to severe multi-collinearity problem and weaken the estimation results. One solution of this dilemma is to use relative performance instead of direct measure of performance. In this chapter I use the percentage changes of firms' market capitalization as a measure of absolute performance, and the average performance of all firms in the market is used as the total market benchmark. Firms are simply indexed as "above total benchmark" or "parallel with or below total benchmark" to proxy for their relative performance compared to the whole market.

In addition to overall market comparison, I also group the firms by industry and calculate the industry benchmarks. Returns of each firm are compared with the corresponding industry benchmark to show their relative performance in the industry. Within industry comparison is necessary as firm performance is strongly affected by industry heterogeneities. Furthermore, executives can be more suitably compared to their peer groups by comparing firm performance with industry benchmark.

The relative performance measures and benchmarks are calculated as below.

$$Ind.Bench_{it} = \begin{cases} 1; & if\ \ R_{it} > \overline{Ind.R_{jt}} \\ 0; & otherwise \end{cases}; \quad where\ \ \overline{Ind.R_{jt}} = \sum_{\forall\, i \in j} \frac{R_{it} - R_{i,t\text{-}1}}{R_{i,t\text{-}1}}$$

$$Tot.Bench_{it} = \begin{cases} 1; & if\ \ R_{it} > \overline{Tot.R_{t}} \\ 0; & otherwise \end{cases}; \quad where\ \ \overline{Tot.R_{t}} = \sum_{\forall\, i} \frac{R_{it} - R_{i,t\text{-}1}}{R_{i,t\text{-}1}}$$

Firm Size

One of the firm observable characteristics of great interest and importance is firm size. The effect of firm size on the amounts of executive compensation is intuitive and is proved. Evidences include, but not limited to, Murphy (1985), who reports large firms tend to pay their executives more than smaller firms, Core and Guay (1999), who show that CEOs' equity incentives are positively related to market value of equity, Gabaix and Landier (2008), who argue that executives' level total pay should increase with firm size. But the effect of firm size on executive compensation structure is not yet studied. For example, the monitoring cost of large firm may be high due to bureaucracy and inefficient communication, suggesting that executives in larger firms should receive a larger portion of restricted stocks and stock options in their compensation packages to be incentivized. On the other hand, the monitoring cost of large firm may also be low because of scale of economy, which implies that larger firms tend to compensate their executives with less equity incentives. Hence, the effect of firm size on the use of equity incentives as a fraction of total compensation is unclear. Here I use the logarithm of sales, LN(S), as the proxy for firm size. The square of log sales, $LN(S)^2$, is also added in the model, to allow for nonlinearity.

Monitoring Power

As previously discussed, the quality of a firm's corporate governance and hence the monitoring power of the board has a significant influence on the structure of compensations to incentivize executives. A firm with better corporate governance system can monitor executives' action with lower cost and hence provide less equity incentives in executives' compensation package. On the other hand, if the firm's corporate governance is loose and difficult to monitor top executives' decision process, it will probably offer more equity incentives to align the executives' personal interest to that of the other shareholders. Unfortunately the costs of firms used to monitor their executives are not directly observable. To measure monitoring power, I use the importance of fixed capital as a proxy variable, because fixed capital is easy to monitor. If a firm has a large portion of fixed capital, it is difficult for the executives to entrench themselves or be extravagant at the cost of shareholders' wealth. Himmelberg et al. (1999) use the ratio of property, plant, and equipment to sales, K/S, as a measure of the importance of fixed capital in the firm. Its squared term, $(K/S)^2$, is also included to allow for nonlinearity, if exists.

Capital Structure

Firm's capital structure may also influence top executives' compensation structure, because of different aims of shareholders and debt holders. Shareholders wants to maximize the residual value of the firms, after repaying debts; while debt holders wants to avoid firm value dropping down to the level below the value of debts. Therefore shareholders prefer projects which are risky but with higher expected value, while debt holders prefer the firm taking less risky projects. To avoid this debt agency cost, debt holders would try to exert influences on the firms' investment decision, through imposing some effect on top executives' compensation structure. John and John (1993) show that firms with higher debt-to-equity ratio use less stock options in the CEOs' compensation packages. Bryan, Hwang, and Lilien (2000) also document a negative relation between the portion of debt in firms and the usage of stocks options as CEOs' incentives. In this chapter I use the ratio of book value of liabilities to book value of assets as a proxy for leverage of the firm, measuring the pressure and monitor from debt holders the executives are facing.

Risk of Firm's Equity

Another important determinant of executive compensation structure is the risk of firm's equity. Except for financial return of the equity, the other side of the tradeoff, the risk of the equity is also a concern of shareholders. Risk sharing is a mechanism widely used in modern business world. For firms' with more volatile equity prices, their executives probably receive more equity incentives. The causal effect may also be reversed. As shown by Bergstresser and Philippon (2006), CEOs with higher level of equity incentives are more likely to manipulate reported earnings to boost stock prices. Also, they find evidence that CEOs sell large blocks of shares and exercise large amounts of options during years of high accruals. Ryan and Wiggins (2001) find that the volatility of operating cash flows is negatively related to cash bonuses but positively related to stock options. Therefore the volatility of stock price is used as a proxy of equity risk and is included in the analyses. There are relatively many observations with missing data in stock volatility, I set the missing volatility to zero and add a dummy variable accordingly to indicate whether the original data is available, in order to maintain sample size.

Free Cash Flow

The ratio of operating income to sales is included as a proxy for market power of firms' free cash flows, which is defined is the cash flow left after projects with positive net cash flows are invested. It measures the gross cash flows available from operations. Jensen (1986) argues that when a firm has sufficient free cash flows, the manager may use the cash to invest in non-profitable projects, rather than paying out to shareholders as dividends. Therefore, he suggests that equity incentive is positively related to a firm's market power of free cash flows. Himmelberg et al. (1999) use operating income to sales to measure the firms' free cash flows, assuming the two are correlated. I also include the same variable in the analyses to control for its possible effect on the structure of executive compensations.

R&D Intensity

R&D intensity is an important factor for executive compensation structure for the following reasons. Firstly, R&D intensive firms are mainly high growth firms. For these firms, the focus is future payoffs of investment decisions rather than the costs of projects or operating efficiency. The potential upward effect on equity price is enormous, if the R&D results turn out to be positive for the firm's future. To incentivize the executives to make right decisions as well as to share the risks, firms with high R&D costs will compensate their executives with large portions of restricted stocks and stock options. Kole (1997)'s evidence shows that the more research-intensive firms compensate their executive with more equity-based awards. Ryan and Wiggins (2001) find a positive relation between R&D intensity and the use of stock options, but a negative relation between R&D intensity and the use of restricted stock. The proxy for R&D intensity is the ratio of R&D expenditures to fixed capitals of the firms. I also set the missing values to zero and include a dummy variable indicating missing R&D expenditure for the same reason of maintaining sample size.

Growth Opportunities

Similar to R&D intensity, growth opportunities of the firms are expected to have positive effects on executives' equity incentive as a fraction of total compensations, as growth opportunities are also forward looking. Core and Guay (1999), for example, find that the optimal amount of restricted stocks and stock options in executive compensations depends on growth opportunities. The ratio of capital expenditure to fixed capital, and the ratio of advertising expenditure to fixed capital are used to control for the firms growth opportunities in this chapter. There are relatively many observations with missing data in advertising expenditure. In order to maintain sample size, I also set the variable to zero when missing, and add a dummy variable to indicate whether the original data is available.

4.4 Data

4.4.1 Data Sources

The main variables of interest are companies' top executives' compensation, which are extracted from ExecuComp. ExecuComp provides information on firms in the S&P 500, the Midcap 400, and the Smallcap 600. Executives' personal characteristics age, gender, whether the executive is holding a doctoral degree, and whether the executive is the current CEO are also extracted from this database. Company basic financial data are collected from Compustat. Data from Compustat are combined with the ExecuComp data using GVKEY as the unique identifier for companies.

The ExecuComp database consists of data from 1992 to 2009 for institutional reasons. Before 1992, listing companies are only required to disclose the executive and director compensations in the narrative disclosure. The U.S. Securities and Exchange Commission (the SEC) adopted changes to the rules requiring executive and director compensation to be disclosed not only in the narrative disclosure but also in the tabular disclosure from 1992. In 2006, the SEC adopted "changes to the rules requiring disclosure of executives and director compensation, related person transactions, director independence and other corporate governance matters, and security ownership of officers and directors (see Release No. 33-8732A). These changes affect disclosure in proxy statements, annual reports and registration statements, as well as the current reporting of compensation arrangements." These changes in requirement not only substantially increase the availability of executive compensation data, but also clarify the allowed methods for option valuation.

To be included in the sample, the observations must have detailed breakdown of total compensation data according to SEC's requirements for at least one year in the range of 2006-2009. Observations with missing data in executive's age, market capitalization, sales, total assets, total liabilities, property, plant & equipment (PP&E), and operating income are excluded from the sample. There are relatively many observations with missing data in stock volatility, R&D expenditure, and advertising expenditure. In order to maintain sample size, I set these variables to zero when they are missing, and add dummy variables accordingly to indicate whether the original data is available. After refining the dataset, my sample consists of 29144 observations in 1821 companies.

4.4.2 Descriptive Statistics

Table 4.2A and Table 4.2B provide descriptive statistics of executive compensations in level and in percentage, respectively. On average, top executives receives 459 thousand USD as base salary, 139 thousand USD as bonus, 725 thousand USD as stock awards, 567 thousand USD as option awards, 423 thousand USD as non-equity incentives, and the value of pension changes and other compensation worth 322 thousand USD. After the first glance we may have the impression that stock awards and option awards comprise the main part of executives' total compensation. Table 4.2B gives more direct insight on whether this interpretation is justifiable.

Table 4.2B shows that an average executive's compensation package consists of 33% of base salary, 5% of bonus, 20% of stock awards, 17% of option awards, 14% of non-equity incentives, and 10% of value changes in pension plan and others. The aggregate 37% of equity incentives seemingly disproves the above insight that stock awards and option awards comprise a dominant part of executives' total compensation. This contradiction is mainly due to the fact that around one fourth of the executives do not receive any stock awards or option awards in their compensation, which is indicated in Table 4.2A and Table 4.2B that the first quartile of stock awards and option awards are zeros, in level or in percentage. Intuitively, this can be interpreted as equity incentives are not granted to all executives, but for those who receive equity incentives, the amounts are large but they comprise relatively small parts of executives' total compensation.

Table 4.2A and Table 4.2B also show that the value of pension changes and other compensation comprise an insignificant part in the executives' total compensation, in USD or in percentage. Also, pension changes are highly regulated and other compensations are too diverse by nature. For these reasons I do not include these two categories of compensations in further analyses.

The descriptive statistics for executives' individual characteristics and firm specific characteristics are provided in Table 4.2C. The executives in the sample have an average age of 52, 7% of these executives are female, and 3% of them hold a doctoral degree. The ratio of CEO executive to non-CEO executives is 1 to 4, in the top executive team of an average firm.

I also present the overtime development of executive compensation in USD and in percentage, in Table 4.3A and Table 4.3B respectively. Roughly speaking, the absolute amounts and percentages of base salary first decreased and then increased while bonus payments were decreasing. The dollar amount of stock awards did not change much, while in percentage it was increasing until 2009. The amount of option awards was decreasing, and it showed similar development in percentage. Non-equity incentives showed an opposite trend compared to base salaries, as both the absolute value and the composition in total compensation first decreased and then increased.

TABLE 4.2A Descriptive Statistics – Executive Compensations

Variable	N	Mean	Std. Dev.	1st Quartile	3rd Quartile
Salary	29144	459	317	269	563
Bonus	29144	139	1030	0	23
Stock Awards	29144	725	1850	0	696
Option Awards	29144	567	1672	0	517
Non-Equity Incentives	29144	423	1007	0	435
Pension Change	29144	165	621	0	47
Other Compensation	29144	157	815	12	98
Total Compensation	29144	2635	4231	685	2856

Source: Compiled by author. Units for the means: thousand $.

TABLE 4.2B Descriptive Statistics – Executive Compensations in Percentage

Variable	Obs	Mean	Std. Dev.	1st Quartile	3rd Quartile
% Salary	29144	33.05	23.14	17.42	43.78
% Bonus	29144	4.91	11.54	0.00	2.28
% Stock Awards	29144	20.03	24.04	0.00	32.64
% Option Awards	29144	17.45	19.85	0.00	27.42
% Non-Equity Incentives	29144	14.21	15.37	0.00	23.11
% Pension Change	29144	4.02	10.98	0.00	3.02
% Other Compensation	29144	6.35	13.18	1.04	5.78

Source: Compiled by author. Units for the means: percent.

TABLE 4.2C Descriptive Statistics – Executive Individual Characteristics and Corporate Financial Fundamentals

Variable	Obs	Mean	Std. Dev.	1st Quartile	3rd Quartile
Executive Individual Characteristics					
Age	29144	51.95	7.57	47.00	57.00
Gender	29144	0.93	0.25	1.00	1.00
PhD	29144	0.03	0.16	0.00	0.00
CEO	29144	0.20	0.40	0.00	0.00
Corporate Financial Fundamentals					
Ind.Bench.	29144	0.46	0.50	0.00	1.00
Tot.Bench.	29144	0.45	0.50	0.00	1.00
LN(S)	29144	7.30	1.67	6.19	8.35
K/S	27912	0.36	0.65	0.09	0.33
Leverage	29144	0.59	1.58	0.40	0.73
SIGMA	29144	28.66	21.60	15.13	41.50
SIGDUM	29144	0.76	0.43	1.00	1.00
Y/S	27968	0.11	1.66	0.08	0.24
(R&D)/K	29144	0.46	1.90	0.00	0.18
RDUM	29144	0.55	0.50	0.00	1.00
A/K	29144	0.15	0.87	0.00	0.05
ADUM	29144	0.39	0.49	0.00	1.00
I/K	25627	0.36	5.09	0.14	0.34

Source: Compiled by author.

TABLE 4.3A Total Compensation Yearly Developments – Total Amounts

Variable	2006	2007	2008	2009	All years
# Observations	N=3989	N=10932	N=10535	N=3688	N=29144
Salary	508	437	455	480	459
Bonus	198	151	122	84	139
Stock Awards	714	714	743	723	725
Option Awards	743	555	539	493	567
Non-Equity Incentives	617	421	359	403	423
Pension Change	215	150	150	198	165
Other Compensation	137	176	155	127	157
Total Compensation	3134	2604	2523	2508	2635

TABLE 4.3B Total Compensation Yearly Developments – Percentage

Variable	2006	2007	2008	2009	All years
# Observations	N=3989	N=10932	N=10535	N=3688	N=29144
% Salary	32.55	32.20	33.58	34.57	33.05
% Bonus	6.94	5.13	4.42	3.41	4.91
% Stock Awards	15.35	19.97	21.52	21.01	20.03
% Option Awards	18.88	17.56	17.19	16.28	17.45
% Non-Equity Incentives	17.17	14.78	12.72	13.53	14.21
% Pension Change	3.99	3.80	3.82	5.27	4.02
% Other Compensation	5.13	6.56	6.74	5.92	6.35
% Total Compensation	100.00	100.00	100.00	100.00	100.00

Source: Compiled by author. Units: thousand $ in Table 4.3A and percent in Table 4.3B.

4.4.3 Comparisons of Means

Before scrutinizing the empirical analyses using sophisticated econometric models, a simple but helpful way to analyze the data is to compare the means of different sub groups. Several noteworthy implications are presented in this section.

CEOs vs. Non-CEO Executives

Table 4.4A provides comparison in compensation amounts and compensation structure between CEOs and non-CEO executives. Column two and column three present the subgroup mean values and the corresponding standard deviations are presented in the parenthesis below. Column four shows the p-values of t-tests, which test the equality of means of two subgroups with different variance[24].

As one may expect, the compensations for CEOs are higher than those for non-CEO executives, in every form of remunerations. The comparisons of interest between these two subgroups are the difference in compensation structures, i.e. the differences in component weights in total compensation. When measured as a portion to total compensations, base salary and bonus payments are less important for CEOs than non-CEO executives. Both stock awards and option awards contribute larger parts to CEOs' compensation packages than those of non-CEO executives. Non-equity incentives also weight higher in CEOs' compensation plans.

The implications from Table 4.4A confirm Ittner, Larcker, and Rajan (1997)'s and Core and Larcker (2001)'s findings that equity incentives are more important for CEOs than non-CEO executives. These findings also provide supporting evidence to the argument that equity incentives are mainly used by firms to lower the agency cost and align interest; while local measures of performance and the potential of being promoted are more important incentives to non-CEO executives.

[24] Considered the sample size, I assume central limit theorem applies and such comparisons are justified.

TABLE 4.4A Compensation Structure Comparison – CEO vs Non-CEO

Variable	CEO	Non-CEO	
# Observations	N=5894	N=23250	p-value
Total Compensation	5440 (6772)	1924 (2883)	0.00
Salary	750 (405)	385 (240)	0.00
Bonus	266 (1932)	107 (616)	0.00
Stock Awards	1571 (3052)	511 (1304)	0.00
Option Awards	1280 (2866)	386 (1123)	0.00
Non-Equity Incentives	936 (1692)	293 (680)	0.00
Pension Change	410 (1115)	103 (386)	0.00
Other Compensation	227 (849)	139 (805)	0.00
% Salary	27.13 (26.51)	34.55 (21.95)	0.00
% Bonus	4.52 (11.66)	5.00 (11.51)	0.00
% Stock Awards	22.09 (27.81)	19.51 (22.96)	0.00
% Option Awards	19.88 (21.14)	16.83 (19.46)	0.00
% Non-Equity Incentives	15.95 (16.33)	13.77 (15.08)	0.00
% Pension Change	5.26 (10.77)	3.71 (11.01)	0.00
% Other Compensation	5.18 (11.13)	6.65 (13.64)	0.00

Source: Compiled by author. Units: Thousand $ for level figures, % for percentage figures.
Note: Standard deviation in parentheses. p-values indicate the significance level of the t-tests, which compare the means of two samples with different variance.

TABLE 4.4B Compensation Structure Comparison – Male vs Female

Variable # Observations	Male N=27199	Female N=1945	p-value
Total Compensation	2683 (4308)	1970 (2870)	0.00
Salary	463 (322)	405 (239)	0.00
Bonus	143 (1064)	78 (253)	0.00
Stock Awards	740 (1892)	514 (1081)	0.00
Option Awards	576 (1671)	442 (1686)	0.00
Non-Equity Incentives	431 (1025)	312 (700)	0.00
Pension Change	170 (638)	93 (297)	0.00
Other Compensation	159 (832)	126 (517)	0.01
% Salary	32.87 (23.29)	35.48 (20.77)	0.00
% Bonus	4.91 (11.57)	4.83 (11.23)	0.77
% Stock Awards	20.06 (24.35)	19.63 (19.14)	0.35
% Option Awards	17.51 (19.94)	16.60 (18.48)	0.04
% Non-Equity Incentives	14.27 (15.38)	13.31 (15.23)	0.01
% Pension Change	4.06 (11.14)	3.52 (8.35)	0.01
% Other Compensation	6.33 (13.16)	6.63 (13.49)	0.34

Source: Compiled by author. Units: Thousand $ for level figures, % for percentage figures.
Note: Standard deviation in parentheses. p-values indicate the significance level of the t-tests, which compare the means of two samples with different variance.

TABLE 4.4C Compensation Structure Comparison – PhD vs Non-PhD

Variable # Observations	PhD N=815	Non-PhD N=28329	p-value
Total Compensation	2789 (5506)	2631 (4189)	0.42
Salary	445 (262)	459 (319)	0.13
Bonus	74 (360)	141 (1043)	0.00
Stock Awards	727 (2434)	725 (1830)	0.98
Option Awards	973 (3028)	555 (1615)	0.00
Non-Equity Incentives	326 (547)	426 (1017)	0.00
Pension Change	115 (656)	166 (620)	0.03
Other Compensation	128 (448)	158 (823)	0.07
% Salary	32.68 (21.61)	33.06 (23.18)	0.62
% Bonus	3.54 (9.55)	4.94 (11.59)	0.00
% Stock Awards	17.29 (19.51)	20.11 (24.15)	0.00
% Option Awards	26.44 (23.61)	17.19 (19.67)	0.00
% Non-Equity Incentives	12.63 (13.16)	14.25 (15.42)	0.00
% Pension Change	1.77 (6.62)	4.08 (11.07)	0.00
% Other Compensation	5.65 (13.17)	6.37 (13.18)	0.12

Source: Compiled by author. Units: Thousand $ for level figures, % for percentage figures.
Note: Standard deviation in parentheses. p-values indicate the significance level of the t-tests, which compare the means of two samples with different variance.

Female Executives vs. Male Executives

Executives are grouped by gender and the comparisons in total compensations and compensation compositions are reported in Table 4.4B. Evidence in Table 4.4B shows that male executives receive higher payments in every form of remunerations than female executives do. The differences are statistically significant and economically noticeable.

It is arbitrary and careless for one to claim that these results provide evidence on wage discrimination in gender. This naïve comparison does not control for other personal characteristics such as experience and ability of executives except for gender, nor does it control for the financial status and attributes of the firms the executives are working for. Any of these factors may contribute significantly to these compensation differences. What we can claim from Table 4.4B is that, as a matter of fact, male executives working for firms in the S&P 500, the Midcap 400, and the Smallcap 600 receive more compensations than their female counterparts on average.

The differences in compensation structures are not as distinctive as they are in USD amounts. Salary weights lower in the compensation plans of male executives, while option awards and non-equity incentives weight higher. Bonus and stock awards compose similar portions in both female and male executives' compensation packages. More sophisticated econometric analyses, which control for other personal characteristics and firm specific characteristics, are carried out in next sections in an attempt to provide further evidence on the structural differences between the compensation packages for female and male executives.

Executives with PhD degree vs. Executives without PhD degree

Table 4.4C reports comparison in compensation amounts and compensation structure between executives with doctoral degree and those without one. The differences in compensations between the two groups are not as obvious. Executives with doctoral degrees receive less bonus payments, non-equity incentives, pension changes and other compensations, but receive more option awards. In total, executives with PhD degrees have larger compensation packages, but the difference is not statistically significant.

In terms of composition, the weights of bonus payments, stock awards, non-equity incentives, and value changes in pension plans are smaller in the compensation package of executives with doctoral degrees. Option awards consists a significantly more important part in doctoral executives' compensation package than that of non-PhD executives.

4.5 Empirical Results

In Section 4.3 I divide the sample into different subgroups and compare the amounts of each compensation components as well as their weights in total compensation plans. Although several interesting facts are shown, it is too arbitrary to infer further implication from the comparisons since no other factors are taken into consideration.

To have a more in-depth insight on the variation of executive compensation structures, I analyze the effects of some important personal observable characteristics and firm observable characteristics on the composition of executive compensation. With the help of modern econometrics, personal unobservable characteristics as well as firm unobservable characteristics can be controlled for under the specification strategy discussed in Section 3.1. Empirical results of the analyses on the sum of salary and bonus as a fraction of total compensation, stock awards as a fraction of total compensation, option awards as a fraction of total compensation, and non-equity incentives as a fraction of total compensation are presented below.

4.5.1 Determinants of Weights of Current Compensation

TABLE 4.5A Determinants of % Salary + Bonus in Total Compensation

Variable	Pooled		Firm Fixed effects		Individual Fixed effects	
Age	-2.898***	-1.736***	-0.604**	-0.552**	-2.391*	-1.712
	(0.172)	(0.169)	(0.253)	(0.272)	(1.228)	(1.296)
Age^2	0.027***	0.017***	0.005**	0.005*	0.023**	0.018
	(0.002)	(0.002)	(0.002)	(0.003)	(0.010)	(0.011)
Gender	-1.801***	-1.581***	-1.465***	-1.503***	--	--
	(0.598)	(0.582)	(0.439)	(0.459)		
PhD	-1.222	-3.485***	0.266	0.031	--	--
	(0.902)	(0.855)	(0.729)	(0.742)		
CEO	-8.085***	-8.418***	-7.621***	-7.766***	-0.046	-0.095
	(0.383)	(0.376)	(0.391)	(0.430)	(1.140)	(1.230)
Ind.Bench.	--	-0.902***	--	-0.872*	--	-0.927***
		(0.346)		(0.449)		(0.316)
Tot.Bench.	--	0.753	--	3.543*	--	0.603
		(1.035)		(1.956)		(1.173)
LN(S)	--	-10.190***	--	-3.787	--	-2.044
		(0.564)		(4.124)		(3.343)
$LN(S)^2$	--	0.261***	--	-0.182	--	-0.167
		(0.037)		(0.295)		(0.262)
K/S	--	-4.785***	--	0.064	--	-0.081
		(0.354)		(2.026)		(1.392)
$(K/S)^2$	--	0.298***	--	-0.122	--	-0.046
		(0.047)		(0.141)		(0.158)
Leverage	--	-0.158*	--	-0.093	--	-0.074
		(0.090)		(0.079)		(0.058)

SIGMA	--	0.080***	--	0.018	--	0.013
		(0.011)		(0.033)		(0.026)
SIGDUM	--	-7.429***	--	-2.630*	--	-2.296*
		(0.568)		(1.475)		(1.169)
Y/S	--	0.189***	--	0.399***	--	0.207*
		(0.088)		(0.109)		(0.115)
(R&D)/K	--	-1.118***	--	-0.504**	--	-0.523***
		(0.083)		(0.204)		(0.142)
RDUM	--	-4.628***	--	-0.328	--	1.129
		(0.327)		(2.142)		(1.495)
A/K	--	-0.071	--	1.619**	--	1.053*
		(0.164)		(0.782)		(0.617)
ADUM	--	3.409***	--	2.053	--	-1.092
		(0.312)		(3.031)		(1.220)
I/K	--	-13.893***	--	-3.279	--	-4.091**
		(0.928)		(2.678)		(1.744)
Adj. R^2 /Overall R^2	0.03	0.19	0.02	0.16	0.01	0.14
p-value (F-test)	--	--	0.00	0.00	0.00	0.00
Hausman	--	--	549.27	350.20	68.61	190.56
p-value (Hausman)	--	--	0.00	0.00	0.00	0.00

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"p-value (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

Table 4.5A reports the analyses of the effects of personal specific characteristics as well as firm specific variables on the importance of current compensation in executives' total compensations, i.e. the ratio of current compensation on total compensations. As discussed before, current compensation is the sum of salary and bonus because both are cash remunerations rewarding for current performance. Base salary is seemingly independent of performance, but it will affect the amount of bonus payment through affecting accounting revenues. Hence, as base salary and bonus payment are actuarially co-determined, they are aggregated as current compensation in the analyses.

The second column of Table 4.5A reports the results of OLS regression with only personal observable characteristics are used as regressors. A concave relation between current compensation and age is located. The result indicates that base salary and bonus compose a larger portion in the compensation plans of younger executives and older executives, compared to middle-age executives, assuming all other variables fixed. Compared to the compensation plans of their male counterparts, base salary and bonus weighted 1.8% higher in female executives' compensation packages. Current compensations weighted 8% higher in non-CEO executives' total compensations. These relations remain statistically significant when firm observable characteristics are controlled. In addition, current compensations weight 3.5% lower in the compensation plans for CEO executives holding a doctoral degree.

When firms' financial variables are taken into consideration, a negative effect of industry benchmark dummy is found but no effect from total benchmark dummy is shown. Intuitively, good firms in their industry tend to pay their executives with smaller portions of salary and bonus. But when firms are compared to the whole market, no difference in current compensation weights is found between above and below average firms. Also, a concave relation between current compensation and firm size is found. The results can be interpreted as, current compensations weight more in compensation plans of executives in smaller firms as well as those of executives in larger firms. Moreover, a similar U shape is found in the relation between weight of current compensations and fixed capital to sales, which is a proxy for monitoring power. The use of financial leverage is found to be negatively related to the use of base salary and bonus payments, which implies that for company with more liabilities, salary and bonus weight smaller in the executives' compensation plan. The effect of equity price volatility on the use of current compensation is positive. The firm's free cash flow, a proxy for agency problem severity, is positively related to the importance of current compensation in executives' total compensations. Proxies for R&D intensity and growth opportunities are all negatively related to the use of current compensations, with the ratio of R&D cost on fixed capital and the ratio of capital expenditure to fixed capital statistically significant. These effects provide evidence from the other side that future oriented firms use more equity incentives.

As discussed in Section 3.1, the simple OLS regressions do not control for the possible effect of unobservable personal characteristics as well as unobservable firm variables on the compositions of executives' compensations. Omitted variable bias exists when unobservable fixed effects have an impact on the explained variable, which leads to biased estimates in OLS regressions. Column four and column five reported regression results using within estimator controlling for the firm fixed effects.

As the figures indicated, the concave relation between age and the weight of current bonus on total compensation remains statistically significant. The negative effects of being a male executive or being at the CEO position also remain after the firms' unobservable characteristics are controlled, though with some changes in calibrations. Among the firms' financial variables, only the negative effect of above industry average dummy, the positive effect of free cash flows, and the negative effect of R&D intensities stay. The other relations located in OLS regression become weak under this specification. An explanation for these changes is that the relations shown in OLS regression results are in fact biased by omitting the firms' unobservable characteristics. When the firm fixed effect is properly controlled for, some superficial relations in OLS regressions are wiped out as well. Another possible but less favorable explanation is after the firms' unobservable characteristics are cancelled out, the left over variations in variables are too small to provide stable estimations. As shown in column six and column seven, the results are even weaker after executives' unobservable characteristics are controlled. Only the negative effect of beating the industry benchmarks, the positive effect of free cash flows, the negative effect of R&D intensities and the negative effect of growth opportunities remain significant.

Although the estimation results from within estimators are weaker than those from OLS regressions, the p-values of F-test show that firms' unobservable characteristics and personal unobservable characteristics are not jointly zero. OLS estimator is inconsistent due to the omitted variable bias. To more formally test the effect of unobservable individual fixed characteristics, I also carry out the Hausman test for misspecifications. Hausman specification test requires the model estimated twice, comparing the error term structures of within estimator and GLS estimator (which assumes that the unobservable heterogeneities are not correlated with other regressors). Intuitively speaking, if the assumption of Hausman test holds, rejection of the null hypothesis indicates that the firm fixed effects, or the unobserved heterogeneities, are correlated with the other regressors. Test results reported clearly reject the assumptions that firm fixed effect is uncorrelated with other regressors. Neglecting this individual effect will lead to the classical omitted variable problem, and is therefore biased. Therefore we should focus on the results of within estimators when interpreting the results.

To summarize, figures in Table 4.5A indicate that executives' age and the importance of base salary and bonus are non-linear related. In more detail, it shows that current compensations compose larger portions in the compensation plans of younger executives and older executives, compared to middle-age executives. This evidence contradicts with Ryan and Wiggins (2001)'s finding that younger and older executives receive less cash bonuses, which again is in contradiction with their own finding that younger and older executives receive less equity incentives in the meantime. As mentioned in the literature review, they argue that both younger and older executives have incentives to focus on shorter term goal than middle-aged group of executives, therefore firms should use less equity incentives in their compensation plans to mitigate the potential risky decisions. I provide evidence better support this argument. In addition, I also provide evidence that base salary and bonus payments weight about 1.5% less in male executives' compensation plans compared to those of female executives, and current compensations compose about 7.8% less in CEOs' total compensations than those of non-CEO executives[25]. Table 4.5A also indicates that for executives in firms that out-perform the industry average, base salary and bonus payment compose smaller portions in their total compensation plans. The use of current compensation is positively related to the firms' free cash flows, which can be interpreted as less incentivized executives use firms' cash less efficiently. Moreover, I provide supporting evidence for the hypothesis that growing firms use less current compensations as I find that R&D intensities and capital investment are both negatively related to the portion of base salary and bonus in executives' total compensations.

[25] Estimations from column five are used, with firm fixed effects controlled.

4.5.2 Determinants of Weights of Stock Awards

TABLE 4.5B Determinants of % Stock Rewards in Total Compensation

Variable	Pooled		Firm Fixed effects		Individual Fixed effects	
Age	0.872***	0.448***	-0.151	-0.220	2.723**	2.863**
	(0.162)	(0.169)	(0.227)	(0.250)	(1.228)	(1.377)
Age²	-0.010***	-0.006***	0.000	0.001	-0.021**	-0.023**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.010)	(0.011)
Gender	0.689	0.252	0.784**	0.743**	--	--
	(0.563)	(0.583)	(0.355)	(0.374)		
PhD	-2.750***	0.786	-0.397	-0.223	--	--
	(0.849)	(0.855)	(0.669)	(0.671)		
CEO	4.055***	4.274***	3.615***	3.786***	6.606***	7.391***
	(0.361)	(0.376)	(0.383)	(0.425)	(2.374)	(2.651)
Ind.Bench.	--	-0.822**	--	-0.131	--	-0.297
		(0.347)		(0.509)		(0.371)
Tot.Bench.	--	-0.821	--	-0.748	--	1.459
		(1.036)		(1.821)		(1.223)
LN(S)	--	5.770***	--	4.846	--	14.814
		(0.565)		(3.160)		(12.345)
LN(S)²	--	-0.164***	--	-0.145	--	-0.699
		(0.037)		(0.250)		(0.767)
K/S	--	5.468***	--	-0.872	--	-0.176
		(0.355)		(2.168)		(1.743)
(K/S)²	--	-0.303***	--	0.114	--	0.104
		(0.047)		(0.173)		(0.126)
Leverage	--	0.106	--	-0.031	--	0.117
		(0.090)		(0.061)		(0.174)

SIGMA	--	0.004	--	-0.074**	--	-0.065**
		(0.011)		(0.036)		(0.033)
SIGDUM	--	-9.581***	--	-0.405	--	-1.178
		(0.568)		(1.839)		(1.528)
Y/S	--	-0.159*	--	-0.232***	--	-0.579*
		(0.088)		(0.088)		(0.321)
(R&D)/K	--	0.214***	--	-0.013	--	0.016
		(0.083)		(0.186)		(0.205)
RDUM	--	1.801***	--	5.767**	--	4.858***
		(0.328)		(2.263)		(1.804)
A/K	--	0.222	--	-2.284**	--	-1.478**
		(0.164)		(1.041)		(0.757)
ADUM	--	-0.476	--	-2.406	--	2.253*
		(0.312)		(3.089)		(1.342)
I/K	--	7.683***	--	0.036	--	-0.061
		(0.929)		(1.847)		(1.496)
Adj. R^2 /Overall R^2	0.01	0.10	0.01	0.04	0.01	0.04
p-value (F-test)	--	--	0.00	0.00	0.00	0.00
Hausman	--	--	81.01	489.91	27.37	182.73
p-value (Hausman)	--	--	0.00	0.00	0.00	0.00

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"p-value (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

Table 4.5B reports the analyses of the effects of personal specific characteristics as well as firm specific variables on the amounts of stock rewards as fractions of executives’ total compensations. Stock awards are mainly used to align the interest of executives to shareholders’ interest and lower agency costs. The values of stocks are directly linked to the companies’ future performance and the incentives are symmetric.

The results of OLS estimation show a concave relation between the use of stock awards and executives’ age. This interesting finding indicates that the ratios of stock awards to total compensations are lower for both younger executives and older executives, compared to that of their middle-aged counterparts. As both groups have incentives to focus on shorter term achievement, less equity incentives should be used accordingly to mitigate over-risk-taking behavior. This result is consistent to Ryan and Wiggins (2001)’s findings and confirms the aforementioned arguments. For CEOs, the weights of stock rewards in their compensation packages is on average 4.1% higher than that of non-CEO executives. As CEOs are at the top positions in the organizations, they need to be incentivized by more equity incentives. For non-CEO executives, local measures of performance and the potentiality of being promoted are more influential incentives.

Good firms in their industry tend to pay their executives with smaller portion of stock awards. Among other firms’ financial variables, firm size and the importance of fixed capital are both found to be concavely related to the use of stock awards. As implied by the figures, stock awards compose smaller parts of executives’ compensation for those working in smaller firms and those working in larger firms. Similarly, stock awards are less important in the remuneration packages for the executives working for firms with less fixed capitals as well as those in firms with more fixed capitals. The ratio of operating income to sales, the proxy of firms’ free cash flows, is found to be negatively related to the amounts of stock awards as a fraction of total compensations. The ratio of R&D expenditures to fixed capital is found to be positively related to the ratio of stock awards to total compensations. This confirms the argument that restricted stock plans are more common in R&D-intensive firms, since they focus more on the future outcomes than current performance. Similar evidence is that the ratio of capital expenditures to fixed capital is positively related to the use of stock rewards.

Column four and column five provide estimations on the effect of personal specific characteristics and firm specific variables on the use of stock rewards, after firms' unobservable characteristics are controlled. The concave relation between the use of stock awards and executives' age found under OLS specification is not significant under this specification. The positive effects of being the CEO on the importance of stock awards remain statistically significant, though with some drifts in calibration. After firm unobservable characteristics is controlled, a new evidence is shown that in the compensation packages for male executives, stock awards are slightly higher than that in female executives' compensation plans. Among the firms' financial variables, the negative effect of being the industry leader is not significant after firm fixed effect is controlled. Free cash flows are shown to be negatively related to the use of stock rewards. A noteworthy new finding is that equity price volatilities are negatively related to the use of stock rewards. Bergstresser and Philippon (2006) argue that CEOs with higher level of equity incentives are more likely to manipulate reported earnings to boost stock prices, and the volatility of equity prices is consequently higher. This opposite evidence shows that firms are successful on using equity incentives as a mechanism for risk sharing. When executives are rewarded with more stocks of the firm, they will try to lower the price fluctuation since they are risk averse. Another new finding in this specification is that the ratio of advertising costs on firms' fixed capital is negatively related to the use of stock, which contradicts to the hypothesis that firms with high growth opportunities reward their executives with more equity incentives.

Estimation results controlling for executives' personal unobservable characteristics are reported in column six and column seven. The first noteworthy finding is that the concave relation between the use of stock awards and executives' age become significant again in this setting. Intuitively, the weights of stock awards are lower in compensation plans for younger executives as well as older executives. This finding supports the argument that both younger executives and older executives groups have incentives to focus on shorter term performance, and hence firms are less intended to rewards both groups of executives with equity incentives to avoid over-risky behaviors. The positive relation between being the CEOs and the use of stock awards remains robust. The negative effect of firms' free cash flows on the use of stock rewards, the negative relation between equity price volatility and the use of stock rewards remain statistically significant. The negative effect of advertising costs still exists but becomes weaker. As the Hausman tests and F-tests indicate, the firms' unobservable characteristics and the executives' unobservable characteristics should not be neglected.

Summarizing the results of Table 4.5B, I find that executives' age is concavely related to the use of stock awards. These results can be interpreted stock rewards compose a smaller portion in total compensations for younger executives and older executives, because both groups have incentives to focus on shorter term performance. Therefore, firms try to mitigate the potential of their over-risky investment decision and reward them with smaller portion of stocks. The positive effects of being the CEO on the importance of stock awards indicate that CEOs need to be incentivized by more equity incentives, while local measures of performance and the potentiality of being promoted are more influential incentives for non-CEO executives. The negative effects of firms' free cash flow on the use of stock awards are robust across specifications. This result is seemingly in contradiction with Jensen (1986)'s argument that executives would use the firms' free cash flow inefficiently when a firm has too much free cash flows, because he implicitly assumes that executives prefer spending the money on irrelevant projects. But it is also possible that executives would be more reluctant to hold redundant cashes and would be more diligent on investing in profitable projects, when their personal wealth are linked to the firms' wealth more closely. Therefore, when they are rewarded by more equity incentives, executives would tend to keep less cash. The negative relation between equity price volatility and the use of stock rewards suggests that firms are successful on using equity incentives as a mechanism for risk sharing. As executives are assumed to be risk averse, they try to lower the risk of firms' equity as they themselves are also holding the firms' equity.

4.5.3 Determinants of Weights of Option Awards

TABLE 4.5C Determinants of % Option Rewards in Total Compensation

Variable	Pooled		Firm Fixed effects		Individual Fixed effects	
Age	0.595***	0.351***	0.503***	0.522***	0.485	0.632
	(0.134)	(0.135)	(0.125)	(0.136)	(1.088)	(1.202)
Age^2	-0.007***	-0.005***	-0.005***	-0.006***	-0.004	-0.005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.009)	(0.010)
Gender	0.898*	0.882*	0.179	0.074	--	--
	(0.465)	(0.466)	(0.327)	(0.358)		
PhD	9.431***	5.588***	0.517	0.569	--	--
	(0.701)	(0.684)	(0.625)	(0.629)		
CEO	3.395***	3.521***	3.274***	3.438***	-0.433	-0.804
	(0.298)	(0.301)	(0.240)	(0.260)	(1.406)	(1.557)
Ind.Bench.	--	-0.579**	--	-1.453***	--	-1.300***
		(0.277)		(0.407)		(0.293)
TotalBench.	--	2.333***	--	-2.788	--	-1.029
		(0.828)		(2.003)		(1.207)
LN(S)	--	0.751*	--	-3.237	--	-8.989**
		(0.452)		(2.548)		(4.026)
LN(S)^2	--	0.012	--	0.136	--	0.404
		(0.029)		(0.197)		(0.269)
K/S	--	0.235	--	2.441	--	1.167
		(0.284)		(1.884)		(1.066)
(K/S)^2	--	-0.065*	--	-0.168	--	-0.120
		(0.038)		(0.114)		(0.076)
Leverage	--	-0.134*	--	0.067	--	-0.018
		(0.072)		(0.054)		(0.064)

SIGMA	--	0.000	--	0.038	--	0.017
		(0.009)		(0.028)		(0.022)
SIGDUM	--	15.704***	--	3.535*	--	4.277***
		(0.454)		(1.362)		(0.997)
Y/S	--	0.107	--	0.095	--	0.295***
		(0.071)		(0.094)		(0.108)
(R&D)/K	--	0.870***	--	0.539**	--	0.562***
		(0.067)		(0.256)		(0.173)
RDUM	--	3.915***	--	-4.210**	--	-3.333**
		(0.262)		(1.916)		(1.523)
A/K	--	-0.027	--	-0.603	--	-0.683
		(0.131)		(0.752)		(0.505)
ADUM	--	-0.430*	--	0.913	--	-0.163
		(0.250)		(1.419)		(1.105)
I/K	--	10.908***	--	0.061	--	1.484
		(0.743)		(1.964)		(1.466)
Adj. R^2 /Overall R^2	0.02	0.16	0.01	0.02	0.00	0.01
p-value (F-test)	--	--	0.00	0.00	0.00	0.00
Hausman	--	--	106.75	491.56	74.64	570.58
p-value (Hausman)	--	--	0.00	0.00	0.00	0.00

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"p-value (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

Table 4.5C documents the estimation results of the effects of personal specific characteristics as well as firm specific variables on the ratio of option awards as a fraction of total compensations. Stock options are originally used to incentivize the executives to concentrate on firms' future performance. However, due to the asymmetric nature of option awards' payoff, executives might make over-risky decisions when options in their compensation packages are out-of-money.

Column two and column three report the estimates from OLS regressions. Similar to the use of stock awards, the use of option awards are also concavely related to executives' age. The weights of option awards seem to be larger in male executives' compensation plans, but the effect is weak. The compensation packages for executives holding a PhD degree comprise more option awards. Firms are found to use higher portion of option awards to compensate their CEOs, compared to non-CEO executives. Because for non-CEO executives, local measures of performance and the potentiality of being promoted are more influential incentives. Therefore option awards are less important in non-CEO executives' compensation packages.

The industry benchmark dummy is found to be negatively related to the use of options, which can be interpreted as for industry leaders, they reward their executives with smaller portions of option awards. A contradicting finding in column three is that the total market benchmark is found to be positively related to the use of options. The negative effect of firms' financial leverage on the use of option awards implies that when a firm faces more pressure from the debt holders, it will use fewer options as remuneration for their executives. The ratio of R&D expenditures to fixed capitals is found to be positively related to the use of option awards, as R&D intensive firms are mainly high growth firms and focus on future performance, they are more likely to incentivize the executives to make right decisions as well as to share the risks. The ratio of capital investments on fixed capital, a proxy for growth opportunities, is also positively related to the use of options. This finding provides further evidence for the argument that growth oriented firms are forward looking and consequently would use more equity incentives to compensate their executives.

The concave relations between the use of option awards and executives' age found under OLS specifications remain statistical significant after firms' unobservable characteristics are controlled, as shown in column four and column five. The positive effect of being the CEOs of the firms on the weights of option awards in total compensation also stays robust. The size of the effect also remains similar, as option awards weight about 3.3% more in CEOs' compensations than that of non-CEO executives' compensations. The negative effect of beating the industry benchmark remains significant, but the effect of beating the total market benchmark vanishes. The positive relation between ratio of R&D expenditures to fixed capitals and the ratio of option awards to total compensation remains significant but becomes weaker.

After executives' personal unobservable characteristics are controlled, the previously found concave relations between the use of option awards and executives' age become weaker and statistically insignificant. The negative effect of being the industry leader remains. A new finding in this specification is the free cash flows of the firms are positively related to the use of options in executives' compensations. This result is consistent with the argument that executives would use the firms' free cash flow inefficiently when a firm has too much free cash flows, since executives preferred spending the money on unprofitable projects to entrench themselves. To mitigate this effect, firms should compensate their executives with more equity incentives like stock options. The positive effect of R&D intensity the use of option awards stay robust. The Hausman tests and F-tests results indicate that the firms' unobservable characteristics and the executives' unobservable characteristics also have impacts on the use of option awards.

To summarize, the use of option awards are found to be concavely related to executives' age, implying that the weights of option awards are smaller in the compensation plans for younger executives as well as those for older executives. These results confirm the arguments that younger executives strive to build up reputation in a short period and older executives want to have better performance before retirement. Therefore both groups need less equity incentives to avoid over-risky behaviors. The positive effect of being at the top position of the firms on the use of option awards confirms the argument that CEOs need more option awards to be incentivized, while non-CEO executives can be incentivized by the potential of being promoted and local measures of performance. Firms performing better than industry average use a smaller portion of option awards in their executives' compensation packages. R&D intensities are also found to have a positive effect on the use of option awards. This finding provide further evidence that R&D intensive firms tend to incentivize their executives by more stock options, as they focus more on growth opportunities and future performance.

4.5.4 Determinants of Weights of Non-Equity Incentives

TABLE 4.5D Determinants of % Non-Equity Incentives in Total Compensation

Variable	Pooled		Firm Fixed effects		Individual Fixed effects	
Age	0.362***	0.171	-0.127	-0.128	1.153	-0.300
	(0.104)	(0.110)	(0.098)	(0.107)	(1.021)	(1.102)
Age^2	-0.003***	-0.002*	0.001	0.001	-0.016**	-0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.008)	(0.008)
Gender	0.636*	0.839**	0.414*	0.447*	--	--
	(0.361)	(0.378)	(0.249)	(0.265)		
PhD	-1.780***	-0.775	0.228	0.274	--	--
	(0.544)	(0.555)	(0.404)	(0.403)		
CEO	1.673***	1.708***	1.571***	1.547***	2.309***	2.740***
	(0.231)	(0.244)	(0.174)	(0.185)	(0.634)	(0.677)
Ind.Bench.	--	3.112***	--	3.028***	--	2.758***
		(0.225)		(0.425)		(0.239)
TotalBench.	--	-0.735	--	-1.004	--	-1.914**
		(0.672)		(1.665)		(0.878)
LN(S)	--	4.192***	--	0.098	--	3.657**
		(0.367)		(1.950)		(1.483)
LN(S)^2	--	-0.206***	--	0.520***	--	0.146
		(0.024)		(0.161)		(0.108)
K/S	--	-1.845***	--	-2.507*	--	-2.081**
		(0.230)		(1.435)		(0.822)
(K/S)^2	--	0.161***	--	0.200**	--	0.130*
		(0.031)		(0.091)		(0.076)
Leverage	--	0.181***	--	-0.004	--	0.061**
		(0.059)		(0.042)		(0.028)

SIGMA	--	-0.086***	--	-0.020	--	-0.011
		(0.007)		(0.024)		(0.013)
SIGDUM	--	2.986***	--	1.701	--	1.262**
		(0.369)		(1.222)		(0.680)
Y/S	--	-0.059	--	-0.245**	--	-0.210**
		(0.057)		(0.102)		(0.084)
(R&D)/K	--	0.183***	--	0.030	--	0.069
		(0.054)		(0.141)		(0.096)
RDUM	--	-1.068***	--	0.481	--	-0.057
		(0.213)		(1.868)		(1.077)
A/K	--	-0.360***	--	0.598	--	0.586
		(0.107)		(0.647)		(0.370)
ADUM	--	-1.332***	--	-2.616*	--	-3.373***
		(0.203)		(1.364)		(0.750)
I/K	--	2.035***	--	2.794*	--	2.951***
		(0.603)		(1.502)		(0.904)
Adj. R^2 /Overall R^2	0.01	0.05	0.01	0.03	0.00	0.02
p-value (F-test)	--	--	0.00	0.00	0.00	0.00
Hausman	--	--	40.95	200.43	95.44	242.79
p-value (Hausman)	--	--	0.00	0.00	0.00	0.00

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"p-value (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

The effects of personal specific characteristics as well as firm specific variables on the ratio of non-equity incentives as a fraction of total compensations are reported in Table 4.5D. Non-equity incentives are a type of cash payments focusing on long-term performance, which can be seen as “long run bonus”. It is usually used for balancing the rewards of short-term financial performance and long-term growth, as well as mitigating over-risk-taking behaviors for executives’ receiving enormous equity incentives.

OLS regression results reported in column two and column three of Table 4.5D show a concave relation between executives’ age and the use of non-equity incentives. It implies that non-equity incentives compose a smaller portion in the compensation plans of younger executives and older executives, compared to middle-age executives. Non-equity incentives are found to weight more in male executives’ compensation plans than those of female executives. In CEOs’ compensation packages, non-equity incentives weight about 1.7% than those in non-CEO executives’ compensation plans.

The industry benchmark dummy is shown to be positively related to the use of non-equity incentives, which means for firms those out-perform their competitors in the industry, non-equity incentive weights higher in executive compensations. A concave relation between the use of non-equity incentives and firm size is found when firms’ financial variables are taken into consideration. Intuitively, the ratios of non-equity incentives to total compensations are smaller for executives working in smaller firms as well as executives in larger firms. Furthermore, a U-shaped relation between the use of non-equity incentives and the ratio of fixed capital to sales is found, which implies that for firms with more fixed capital as well as less fixed capital, non-equity incentives weight more in executives’ compensation plans. The use of financial leverage is found to be positively correlated with the use of non-equity incentives. This indicates that for executives facing higher pressures from debt holders, their compensation plans contain higher portion of non-equity incentives.

This finding also partly support John and John (1993)'s and Bryan, Hwang, and Lilien (2000)'s finding that firms with higher debt-to-equity ratio used less stock options in the CEOs' compensation packages. Results in Table 4.5D also show that for firms' with more volatile equity prices, non-equity incentives are less important in their executives' compensation plans. R&D intensity is shown to have a positive effect on the use of non-equity incentives, supporting the common understanding that R&D intensive firms are forward looking. The effect of growth opportunity proxies on the use of non-equity incentives are contradicting. Advertising cost is found to have a negative effect on the use of non-equity incentives, while the ratio of capital expenditure to fixed capital has a positive effect.

Column four and column five report the estimation results after firms' unobservable characteristics are controlled. The previously located concave relation between executives' age and the importance of non-equity incentives in their total compensations is not significant. The positive effect of being a male executive and the positive effect of sitting on the chair of CEO remain statistically significant. However, the concave relation between the ratios of non-equity incentives to total compensations and firm sizes fail to remain significant, while the U-shaped relation between the use of non-equity incentives and the ratio of fixed capital to sales remains but becomes weaker. The strong positive effect of performing above industry average on the use of non-equity incentives remains robust. The contradiction among growth opportunity proxies is gone, with only the positive effect of the ratio of capital expenditure to fixed capital on the use of non-equity incentives remains robust. A new finding in this specification is the use of non-equity incentives is negatively related to the firms' free cash flows. This result is partly consistent with the argument that too much free cash flows will leads to higher agency costs, and therefore, less cash compensations should be used to mitigate this problem.

After the executives' unobservable characteristics are cancelled out, the weight difference between of non-equity incentives in CEOs' total compensations and that in non-CEO executives' compensations stays. Intuitively, non-equity incentives weight about 2.5% higher in CEOs' compensation plans. Among the firms' financial variables, the positive effect of beating the industry benchmark, the U-shaped relation between the use of non-equity incentives and the ratio of fixed capital to sales, and the positive effect of firm size and leverage on the use of non-equity incentives remain statistically significant. The negative relation between the use of non-equity incentives and operating income to sales located before stays robust, so does the positive effect of the ratio of capital expenditure to fixed capital on the ratio of non-equity incentives to executives' total compensations. The results of Hausman tests and F-tests show that firms' fixed effect and individual fixed effect are correlated with the firm- and executive observable characteristics, which implies that the OLS regression results are biased.

In summary, Table 4.5D offers evidence that in CEOs' compensation packages, non-equity incentives weight higher than those in non-CEO executives. For male executives, non-equity incentives are found to have higher weights in their compensation plans than those of female executives. For executives working in an above-industry-average firm, or those working in a larger firm, non-equity incentives compose a larger portion in the compensation packages. Moreover, a U-shaped relation between the use of non-equity incentives and the ratio of fixed capital to sales is found, which implies that for firms with more fixed capital as well as less fixed capital, non-equity incentives weight more in executives' compensation plans. The positive effect of use of financial leverage on the use of non-equity incentives indicates that for executives facing higher pressures from debt holders, their compensation plans contain higher portion of non-equity incentives. The use of non-equity incentives is found to be negatively related to the firms' free cash flows. The ratio of capital expenditure to fixed capital has a positive effect on the use of non-equity incentives, which indicates that growth oriented firms use more long term cash bonus to reward their executives long term performance.

4.6 Summary

This chapter analyzes the effects of personal specific characteristics and firm specific characteristics on the compositions of executive compensation, which are measured as the sum of salary and bonus as a fraction of total compensation, stock awards as a fraction of total compensation, option awards as a fraction of total compensation, and non-equity incentives as a fraction of total compensation. Some noteworthy evidences are found.

First, the executives' age and the importance of base salary and bonus is non-linear related. In more detail, empirical evidence shows that current compensations compose larger portions in the compensation plans of younger executives and older executives, compared to middle-age executives. This evidence supports the argument that younger and older executives should receive more cash bonuses, because both groups of executives have incentives to focus on shorter term goals. In addition, I also provide evidence that base salary and bonus payments weight less in male executives' compensation plans compared to those of female executives, and current compensations weight less in CEOs' total compensations than those of non-CEO executives. Empirical evidence also indicates that for executives working for industry leaders, base salary and bonus payment compose a smaller portion in their total compensation plans. The use of current compensation is found to be positively related to the firms' free cash flows. Moreover, I provide supporting evidence for the hypothesis that growing firms use less current compensations as I find that R&D intensities and capital investment are both negatively related to the portion of base salary and bonus in executives' total compensations.

Second, I find that executives' age is concavely related to the use of stock awards. These results can be interpreted as stock rewards compose a smaller portion in total compensations for younger and older executives, because both groups have incentives to focus on shorter term performance. Therefore, firms try to mitigate their tendency to make over risky investment decision and reward them with smaller portion of stocks. The positive effects of being the CEO on the importance of stock awards indicate that CEOs need to be incentivized by more equity incentives, while local measures of performance and the potentiality of being promoted are more influential incentives for non-CEO executives. The negative effects of firms' free cash flow on the use of stock awards may be interpreted as executives tend to keep less cash and are reluctant to hold redundant cashes when their wealth are linked to the firms' wealth more closely. The negative relation between equity price volatility and the use of stock rewards suggests that firms are successful on using equity incentives as a mechanism for risk sharing. As executives are assumed to be risk averse, they try to lower the risk of firms' equity as they themselves are also holding the firms' equity.

Third, the use of option awards is found to be concavely related to executives' age, with a U-shaped pattern similar to the relation between the use of stock awards and executives' age. These results confirm the arguments that younger executives strive to build up reputation in a short period and older executives want to have better performance before retirement and hence more short-sighted. The positive effect of being at the top position of the firms on the use of option awards is also in accordance to the findings in the use of stock awards. Good firms in the industry use less option awards to reward their executives, which can be seen as an attempt to avoid over-risky behavior. R&D intensities are also found to have a positive effect on the use of option awards. This finding provides further evidence that R&D intensive firms tend to incentivize their executives by more stock options, as they focus more on growth opportunities and future performance.

Fourth, empirical evidence shows that in CEOs' compensation packages, non-equity incentives weight higher than those in non-CEO executives. For male executives, non-equity incentives are found to have higher weights in their compensation plans than those of female executives. The positive effect of performing above the industry benchmark on the use of non-equity incentives indicates that above-industry firms use larger portions of non-equity incentives to reward their executives. Also, non-equity incentives weight higher in the compensation plans for executives of larger firms. Moreover, a U-shaped relation between the use of non-equity incentives and the ratio of fixed capital to sales is found, implying that for firms with more fixed capital as well as less fixed capital, non-equity incentives weight more in executives' compensation plans. The positive effect of financial leverage on the use of non-equity incentives indicates that for executives facing higher pressures from debt holders, their compensation plans contain higher portion of non-equity incentives. Considering that non-equity incentives can be seen as a long-term cash bonus, this finding also supports the argument that firms with higher debt-to-equity ratio use less stock options and more cash bonus in the CEOs' compensation packages. The use of non-equity incentives is found to be negatively related to the firms' free cash flows. This result supports the argument that too much free cash flows will leads to higher agency costs, and as a result less cash compensations should be used to mitigate this problem. The ratio of capital expenditure to fixed capital has a positive effect on the use of non-equity incentives, which shows that growth oriented firms use more long term cash bonus to reward their executives for long term performance.

All the aforementioned findings are summarized in Table 4.6. As we can see in Table 4.6, the only important factors influencing almost all forms of executive remunerations are age, the position of the executives, and industry-wide relative performance. In general, younger and older executives receive more current compensation but less equity incentives. CEOs receive more equity incentives and long-term performance bonus than non-CEO executives. For the firms over-performed the industry average, the compensation package of their executives contain less salary and bonus, less stock options, but more non-equity incentives. Certain firm characteristics, such as the importance of free cash flows and growth opportunities, show significant influence on some of the compensation types. The rest of the hypothesized relations are either weak or statistically insignificant. This may be due to the method I used to control for personal fixed effect and firm fixed effect. In the within estimators, only the within group variations are used for estimation, which may not be diverse enough to have stable estimation results. More robust results might be found when more sophisticated econometric methods are proposed, or when more data are available in the future.

TABLE 4.6 Summary of Results

Compensation Components	% Base Salary + Bonus	% Stocks Awards	% Options Awards	% Non-Equity Incentives
Age	U Shape	Inverse U Shape	Inverse U Shape	--
CEO (1=CEO)	Negative	Positive	Positive	Positive
Gender (1=male)	Negative	--	--	Positive
Over Industry Average	Negative	--	Negative	Positive
Importance of Fixed Capital	--	--	--	U Shape
Equity Price Volatility	--	Negative	--	--
Free Cash Flows	Positive	Negative	--	Negative
R&D Intensities	Negative	--	Positive	--
Growth Opportunities	Negative	--	--	Positive

Source: Compiled by author.

Note: “--” indicates that no statistical relation is found, or the relation is not robust to different specifications.

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Appendix

TABLE 2.4B Determinants of firm value (Tobin's Q), quadratic specification, managerial holding variables in first lag

Variable	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects
lag m	1.527***	0.981**	1.151***	0.824***	0.866*	0.749**	0.856***	0.830*	0.885***
	(0.182)	(0.410)	(0.308)	(0.170)	(0.451)	(0.294)	(0.175)	(0.452)	(0.301)
(lag m)^2	-0.027	0.174	-0.007	0.212***	0.156	0.064	0.360***	0.259	0.059
	(0.181)	(0.182)	(0.103)	(0.082)	(0.195)	(0.094)	(0.080)	(0.196)	(0.098)
LN(S)	--	--	--	-0.824***	-0.590***	-0.656***	-1.148***	-0.684***	-0.676***
				(0.084)	(0.130)	(0.129)	(0.084)	(0.133)	(0.133)
LN(S)^2	--	--	--	0.050***	0.039***	0.029***	0.068***	0.044***	0.031***
				(0.005)	(0.009)	(0.009)	(0.005)	(0.009)	(0.010)
K/S	--	--	--	-0.052***	-0.060***	-0.176***	-0.213***	-0.093***	-0.188***
				(0.019)	(0.020)	(0.048)	(0.026)	(0.023)	(0.051)
(K/S)^2	--	--	--	0.000***	0.000***	0.001***	0.001***	0.001***	0.001***
				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SIGMA	--	--	--	-0.005***	-0.004*	-0.003	0.000	-0.004	-0.004
				(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)

SIGDUM	--	--	--	0.277***	0.178*	0.072	0.147**	0.179	0.087
				(0.065)	(0.106)	(0.095)	(0.067)	(0.110)	(0.096)
Y/S	--	--	--	0.016***	0.012**	-0.012*	0.005	0.013*	-0.012
				(0.005)	(0.006)	(0.007)	(0.010)	(0.006)	(0.008)
(R&D)/K	--	--	--	-0.002	-0.006***	-0.003***	--	--	--
				(0.003)	(0.001)	(0.001)			
RDUM	--	--	--	0.508***	0.366***	-0.056	--	--	--
				(0.025)	(0.086)	(0.079)			
A/K	--	--	--	0.086**	0.090	0.195*	--	--	--
				(0.037)	(0.078)	(0.113)			
ADUM	--	--	--	0.218***	0.127**	-0.175**	--	--	--
				(0.028)	(0.056)	(0.068)			
I/K	--	--	--	2.156***	1.804***	1.334***	--	--	--
				(0.282)	(0.421)	(0.318)			
R^2	0.02	0.02	0.02	0.17	0.16	0.11	0.08	0.07	0.07
p-value (F-test)	--	0.00	0.00	--	0.00	0.00	--	0.00	0.00
Hausman	--	-29.61	159.53	--	69.73	307.27	--	128.11	315.06

p-value (Hausman)	--	--	0.00	--	0.00	0.00	--	0.00	0.00
Wald	55.76	19.82	16.19	54.85	23.16	12.72	95.41	24.96	15.02
p-value (Wald)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p-value (serial corr.)	--	--	0.00	--	--	0.00	--	--	0.00
AIC	104476	98349	85948	100262	96941	85013	102783	97991	85587
BIC	104631	98497	86095	100515	97186	85289	102995	98195	85792

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

“p-value (F-test)” reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.

“Hausman” and “p-value (Hausman)” report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

“Wald” and “p-value (Wald-test)” are test statistics and their corresponding p-values of the Wald tests for joint significance of managerial holding variables.

“p-value (serial corr.)” reports the p-values of Wooldridge’s test for serial correlation in the errors terms of panel models. e.g., a p-value of 0 rejects the null hypothesis that there is no first order autocorrelation in the error terms.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

R^2 reports the adjusted R^2 value in the column of OLS, and overall R^2 value in the columns of within estimators.

TABLE 2.4C Determinants of firm value (Tobin's Q), quadratic specification, managerial holding variables in first difference

Variable	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects
Δm	-1.034***	-0.686***	-0.459***	-0.854***	-0.601***	-0.429**	-1.068***	-0.716***	-0.500***
	(0.249)	(0.226)	(0.178)	(0.223)	(0.208)	(0.172)	(0.243)	(0.233)	(0.178)
$(\Delta m)^2$	0.759***	0.604***	0.358***	0.473***	0.502***	0.257**	0.650***	0.596***	0.288***
	(0.194)	(0.116)	(0.107)	(0.139)	(0.103)	(0.102)	(0.135)	(0.121)	(0.102)
LN(S)	--	--	--	-0.828***	-0.595***	-0.667***	-1.148***	-0.688***	-0.688***
				(0.084)	(0.130)	(0.129)	(0.084)	(0.133)	(0.134)
$LN(S)^2$	--	--	--	0.049***	0.039***	0.030***	0.067***	0.044***	0.031***
				(0.005)	(0.009)	(0.009)	(0.005)	(0.009)	(0.010)
K/S	--	--	--	-0.058***	-0.060***	-0.177***	-0.219***	-0.093***	-0.189***
				(0.019)	(0.020)	(0.049)	(0.027)	(0.023)	(0.051)
$(K/S)^2$	--	--	--	0.000***	0.000***	0.001***	0.001***	0.001***	0.001***
				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SIGMA	--	--	--	-0.005***	-0.005*	-0.003	0.000	-0.004	-0.004
				(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
SIGDUM	--	--	--	0.269***	0.172	0.077	0.138***	0.172	0.093
				(0.065)	(0.105)	(0.095)	(0.067)	(0.110)	(0.097)

Y/S	--	--	--	0.015*** (0.005)	0.012** (0.006)	-0.012* (0.007)	0.004 (0.010)	0.013** (0.006)	-0.012 (0.008)
(R&D)/K	--	--	--	-0.002 (0.003)	-0.006*** (0.001)	-0.003*** (0.001)	--	--	--
RDUM	--	--	--	0.493*** (0.024)	0.353*** (0.085)	-0.059 (0.080)	--	--	--
A/K	--	--	--	0.088** (0.038)	0.090 (0.078)	0.196* (0.113)	--	--	--
ADUM	--	--	--	0.231*** (0.028)	0.130** (0.057)	-0.174** (0.068)	--	--	--
I/K	--	--	--	2.171*** (0.284)	1.806 (0.422)	1.340*** (0.319)	--	--	--
R^2	0.02	0.02	0.02	0.17	0.16	0.11	0.08	0.07	0.07
p-value (F-test)	--	0.00	0.00	--	0.00	0.00	--	0.00	0.00
Hausman	--	279.24	871.54	--	44.50	338.94	--	27.02	-120.56
p-value (Hausman)	--	0.00	0.00	--	0.02	0.00	--	0.30	--

Wald	20.25	34.60	11.31	19.17	43.65	9.19	32.35	30.52	11.62
p-value (Wald)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p-value (serial corr.)	--	--	0.00	--	--	0.00	--	--	0.00
AIC	104591	98408	85983	100305	96989	85027	102826	98035	85606
BIC	104746	98555	86130	100558	97234	85273	103039	98239	85810

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"p-value (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

"Wald" and "p-value (Wald-test)" are test statistics and their corresponding p-values of the Wald tests for joint significance of managerial holding variables.

"p-value (serial corr.)" reports the p-values of Wooldridge's test for serial correlation in the errors terms of panel models. e.g., a p-value of 0 rejects the null hypothesis that there is no first order autocorrelation in the error terms.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

R^2 reports the adjusted R^2 value in the column of OLS, and overall R^2 value in the columns of within estimators.

TABLE 2.5B Determinants of firm value (Tobin's Q), spline specification, managerial holding variables in first lag

Variable	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects
lag m1	4.908***	0.521	1.160	-0.735	-0.721	0.942	-0.082	-0.491	0.961
	(0.751)	(1.318)	(1.202)	(0.774)	(1.338)	(1.166)	(0.784)	(1.380)	(1.193)
lag m2	0.643*	1.185	1.203**	1.317***	1.367**	0.741	1.201***	1.276*	0.916*
	(0.328)	(0.722)	(0.552)	(0.301)	(0.691)	(0.545)	(0.336)	(0.709)	(0.554)
lag m3	1.077**	0.833	0.777	0.692*	0.669	0.633	0.941**	0.790	0.708
	(0.425)	(0.721)	(0.524)	(0.375)	(0.645)	(0.499)	(0.476)	(0.751)	(0.521)
LN(S)	--	--	--	-0.826***	-0.591***	-0.656***	-1.149***	-0.685***	-0.675***
				(0.084)	(0.130)	(0.129)	(0.084)	(0.133)	(0.133)
LN(S)^2	--	--	--	0.050***	0.039***	0.029***	0.068***	0.044***	0.031***
				(0.005)	(0.009)	(0.009)	(0.005)	(0.009)	(0.010)
K/S	--	--	--	-0.054***	-0.060***	-0.176***	-0.214***	-0.093***	-0.188***
				(0.019)	(0.020)	(0.048)	(0.027)	(0.023)	(0.051) ***
(K/S)^2	--	--	--	0.000***	0.000***	0.001***	0.001***	0.001***	0.001
				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000) ***
SIGMA	--	--	--	-0.005***	-0.005*	-0.003	0.000	-0.004	-0.004
				(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)

SIGDUM	--	--	--	0.279*** (0.065)	0.179* (0.106)	0.072 (0.095)	0.149** (0.067)	0.180 (0.110)	0.088 (0.096)
Y/S	--	--	--	0.015*** (0.005)	0.012** (0.006)	-0.012* (0.007)	0.005 (0.010)	0.013 (0.006)	-0.012 (0.008)
(R&D)/K	--	--	--	-0.002 (0.003)	-0.006*** (0.001)	-0.003*** (0.001)	--	--	--
RDUM	--	--	--	0.506*** (0.025)	0.365*** (0.086)	-0.056 (0.079)	--	--	--
A/K	--	--	--	0.086** (0.037)	0.089 (0.078)	0.195* (0.113)	--	--	--
ADUM	--	--	--	0.218*** (0.028)	0.127** (0.056)	-0.175*** (0.068)	--	--	--
I/K	--	--	--	2.165*** (0.284)	1.809*** (0.422)	1.334*** (0.318)	--	--	--
R^2	0.02	0.02	0.02	0.17	0.16	0.11	0.08	0.07	0.07
p-value (F-test)	--	0.00	0.00	--	0.00	0.00	--	0.00	0.00
Hausman	--	-9.01	182.15	--	69.14	316.56	--	129.89	312.98

p-value (Hausman)	--	--	0.00	--	0.00	0.00	--	0.00	0.00
Wald	46.06	3.85	6.57	15.78	3.02	3.49	16.09	2.85	4.48
p-value (Wald)	0.00	0.01	0.00	0.00	0.03	0.02	0.00	0.04	0.00
p-value (serial corr.)	--	--	0.00	--	--	0.00	--	--	0.00
AIC	104457	98352	85949	100260	96937	85105	102787	97990	85589
BIC	104620	98507	86105	100522	97191	85268	103008	98203	85801

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"p-value (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

"Wald" and "p-value (Wald-test)" are test statistics and their corresponding p-values of the Wald tests for joint significance of managerial holding variables.

"p-value (serial corr.)" reports the p-values of Wooldridge's test for serial correlation in the errors terms of panel models. e.g., a p-value of 0 rejects the null hypothesis that there is no first order autocorrelation in the error terms.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

R^2 reports the adjusted R^2 value in the column of OLS, and overall R^2 value in the columns of within estimators.

TABLE 2.5C Determinants of firm value (Tobin's Q), spline specification, managerial holding variables in first difference

Variable	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects	Pooled	SIC3 effects	Firm effects
Δm1	1.239	1.830*	1.283	0.279	1.104	0.709	0.011	1.236	0.725
	(1.309)	(0.939)	(1.068)	(1.232)	(0.904)	(1.091)	(1.268)	(0.899)	(1.086)
Δm2	-1.110**	-0.789*	-0.557	-0.826*	-0.637	-0.475	-0.837*	-0.668	-0.517
	(0.482)	(0.417)	(0.353)	(0.445)	(0.393)	(0.349)	(0.477)	(0.424)	(0.356)
Δm3	-1.914*	-1.606***	-1.007***	-1.380***	-1.311***	-0.804**	-1.880***	-1.634***	-0.941***
	(0.491)	(0.483)	(0.333)	(0.420)	(0.422)	(0.315)	(0.510)	(0.493)	(0.325)
LN(S)	--	--	--	-0.827***	-0.594***	-0.665***	-1.148***	-0.687***	-0.686***
				(0.084)	(0.130)	(0.129)	(0.084)	(0.133)	(0.134)
LN(S)^{2}	--	--	--	0.049***	0.039***	0.029***	0.067***	0.044***	0.031***
				(0.005)	(0.009)	(0.009)	(0.005)	(0.009)	(0.010)
K/S	--	--	--	-0.058***	-0.060***	-0.177***	-0.220***	-0.093***	-0.189***
				(0.019)	(0.020)	(0.048)	(0.027)	(0.023)	(0.051)
(K/S)^{2}	--	--	--	0.000***	0.000***	0.001***	0.001***	0.001***	0.001***
				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SIGMA	--	--	--	-0.005***	-0.005*	-0.003	0.000	-0.004	-0.004
				(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)

SIGDUM	--	--	--	0.269*** (0.065)	0.171 (0.105)	0.077 (0.095)	0.138** (0.067)	0.172 (0.110)	0.093 (0.097)
Y/S	--	--	--	0.015*** (0.005)	0.012** (0.006)	-0.012* (0.007)	0.004 (0.010)	0.013** (0.006)	-0.012 (0.008)
(R&D)/K	--	--	--	-0.002 (0.003)	-0.006*** (0.001)	-0.003*** (0.001)	--	--	--
RDUM	--	--	--	0.493*** (0.024)	0.353*** (0.085)	-0.059 (0.080)	--	--	--
A/K	--	--	--	0.088*** (0.038)	0.090 (0.078)	0.196* (0.114)	--	--	--
ADUM	--	--	--	0.231*** (0.028)	0.131** (0.057)	-0.174** (0.068)	--	--	--
I/K	--	--	--	2.171*** (0.283)	1.806*** (0.421)	1.340*** (0.318)	--	--	--
R^2	0.02	0.02	0.02	0.17	0.16	0.11	0.08	0.07	0.07
p-value (F-test)	--	0.00	0.00	--	0.00	0.00	--	0.00	0.00
Hausman	--	398.04	105.33	--	-184.54	349.61	--	28.57	13.42

p-value (Hausman)	--	0.00	0.00	--	--	0.00	--	0.28	0.94
Wald	8.93	5.05	4.67	7.05	4.54	3.68	8.52	4.69	4.56
p-value (Wald)	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
p-value (serial corr.)	--	--	0.00	--	--	0.00	--	--	0.00
AIC	104592	98404	85981	100307	96989	85027	102829	98034	85606
BIC	104756	98560	86136	100568	97242	85281	103050	98246	85818

Source: Compiled by author.

Note: Standard deviations are reported in brackets. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

“p-value (F-test)” reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero, i.e., individual fixed effects exist.

“Hausman” and “p-value (Hausman)” report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

“Wald” and “p-value (Wald-test)” are test statistics and their corresponding p-values of the Wald tests for joint significance of managerial holding variables.

“p-value (serial corr.)” reports the p-values of Wooldridge’s test for serial correlation in the errors terms of panel models. e.g., a p-value of 0 rejects the null hypothesis that there is no first order autocorrelation in the error terms.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

R^2 reports the adjusted R^2 value in the column of OLS, and overall R^2 value in the columns of within estimators.

TABLE 3.4A Effects of Equity Incentives on Firm Performance – Pooled OLS (with lagged Equity Incentive Variables)

Variable	1992-2005 Sample Pooled OLS		2006-2009 Sample Pooled OLS	
lag Stocks	-0.003	0.002	-0.012***	-0.026**
	(0.002)	(0.001)	(0.002)	(0.010)
(lag Stocks)^2	5.4E^{-07}	-3.4E^{-07}	1.8E^{-05} ***	4.0E^{-05} **
	(0.000)	(0.000)	(0.000)	(0.000)
lag Options	0.012***	0.011***	0.012***	0.015***
	(0.002)	(0.001)	(0.001)	(0.002)
(lag Options)^2	-7.1E^{-07} ***	-6.4E^{-07} ***	-2.2E^{-05} ***	-3.0E^{-05} ***
	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-0.808***		-2.986**
		(0.050)		(1.250)
LN(S)^2		0.046***		0.186**
		(0.003)		(0.079)
K/S		-0.100***		-0.017
		(0.011)		(0.051)
(K/S)^2		0.001***		-0.009
		(0.000)		(0.006)
Sigma		-0.005***		0.002
		(0.001)		(0.008)
Sig_dum		0.284***		-0.155
		(0.044)		(0.272)
Y/S		0.014**		0.018
		(0.006)		(0.020)
(R&D)/K		-0.002		-0.076
		(0.002)		(0.061)
R&D_dum		0.460***		0.264***
		(0.014)		(0.029)

A/K		0.107*** (0.023)		0.002 (0.014)
A_dum		0.162*** (0.016)		0.164*** (0.026)
I/K		2.193*** (0.169)		-0.006** (0.003)
Adj. R^2	0.04	0.18	0.01	0.14
Wald	16.38	28.84	31.16	27.95
p-value (Wald)	0.00	0.00	0.00	0.00
AIC	355249	341898	83170	80575
BIC	355409	342170	83225	80724

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"Wald" and "p-value (Wald-test)" are test statistics and their corresponding p-values of the Wald tests for joint significance of equity incentive variables.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

TABLE 3.4B Effects of Equity Incentives on Firm Performance – Firm Fixed Effects (with lagged Equity Incentive Variables)

Variable	1992-2005 Sample Firm Fixed Effect		2006-2009 Sample Firm Fixed Effect	
lag Stocks	0.002***	0.002**	-0.004***	-0.008*
	(0.001)	(0.001)	(0.002)	(0.005)
(lag Stocks)^2	-4.6E^{-07} ***	-3.6E^{-07} **	8.0E^{-06} ***	1.6E^{-05} *
	(0.000)	(0.000)	(0.000)	(0.000)
lag Options	0.004***	0.004***	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
(lag Options)^2	-2.5E^{-07} ***	-2.5E^{-07} ***	7.8E^{-07}	1.7E^{-06}
	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-0.606***		-15.011
		(0.192)		(10.180)
LN(S)^2		0.026*		0.944
		(0.013)		(0.677)
K/S		-0.206***		-0.497
		(0.056)		(0.635)
(K/S)^2		0.001*		0.028
		(0.001)		(0.038)
Sigma		-0.006**		-0.043
		(0.002)		(0.035)
Sig_dum		0.186*		1.100
		(0.104)		(1.073)
Y/S		-0.016*		0.264*
		(0.009)		(0.159)
(R&D)/K		-0.002***		-0.737
		(0.001)		(0.523)
R&D_dum		-0.074		-0.015
		(0.074)		(0.123)

A/K		0.280*		0.144
		(0.155)		(0.156)
A_dum		-0.215***		0.272
		(0.070)		(0.540)
I/K		1.314***		-0.078
		(0.370)		(0.469)
Overall R^2	0.22	0.11	0.01	0.11
p-value (F-test)	0.00	0.00	0.00	0.00
Hausman	-402.51	185.60	23.53	2446.89
p-value (Hausman)	--	0.00	0.00	0.00
Wald	9.76	9.24	3.47	1.21
p-value (Wald)	0.00	0.00	0.01	0.31
AIC	291127	288509	60579	54850
BIC	291277	288771	60626	54991

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"p-value (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

"Wald" and "p-value (Wald-test)" are test statistics and their corresponding p-values of the Wald tests for joint significance of equity incentive variables.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

TABLE 3.4C Effects of Equity Incentives on Firm Performance – Firm & Individual Fixed Effects (with lagged Equity Incentive Variables)

Variable	1992-2005 Sample Firm & Invd. Fixed Effect		2006-2009 Sample Firm & Invd. Fixed Effect	
lag Stocks	0.003**	0.002**	-0.016***	-0.033**
	(0.001)	(0.001)	(0.005)	(0.013)
(lag Stocks)^2	-6.3E^{-07} **	-5.0E^{-07} **	9.0E^{-05} **	8.7E^{-06}
	(0.000)	(0.000)	(0.000)	(0.000)
lag Options	0.004***	0.004***	-0.002	-0.004*
	(0.001)	(0.001)	(0.002)	(0.002)
(lag Options)^2	-2.4E^{-07} ***	-2.4E^{-07} ***	3.4E^{-06}	8.5E^{-06} **
	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-0.453***		-18.029**
		(0.127)		(7.858)
LN(S)^2		0.019**		1.133**
		(0.009)		(0.516)
K/S		-0.248***		-0.451
		(0.027)		(0.394)
(K/S)^2		0.001***		0.021
		(0.000)		(0.023)
Sigma		-0.004***		-0.053*
		(0.001)		(0.029)
Sig_dum		0.142**		1.423
		(0.058)		(0.888)
Y/S		-0.011*		0.326**
		(0.006)		(0.131)
(R&D)/K		-0.001***		-0.833**
		(0.000)		(0.375)
R&D_dum		-0.080*		0.006
		(0.042)		(0.082)

A/K		0.158***		0.062
		(0.046)		(0.084)
A_dum		-0.147***		0.453
		(0.038)		(0.436)
I/K		1.047***		-0.313
		(0.173)		(0.358)
Overall R^2	0.02	0.11	0.01	0.11
p-value (F-test)	0.00	0.00	0.00	0.00
Hausman	1199.56	1993.51	76.35	3442.16
p-value (Hausman)	0.00	0.00	0.00	0.00
p-value (serial corr.)	0.00	0.00	0.00	0.00
Wald	6.56	11.00	4.24	2.62
p-value (Wald)	0.00	0.00	0.00	0.03
AIC	264484	262913	60152	52956
BIC	264634	263176	60199	53096

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"p-value (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

"Wald" and "p-value (Wald-test)" are test statistics and their corresponding p-values of the Wald tests for joint significance of equity incentive variables.

"p-value (serial corr.)" reports the p-values of Wooldridge's test for serial correlation in the errors terms of panel models. e.g., a p-value of 0 rejects the null hypothesis that there is no first order autocorrelation in the error terms.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

TABLE 3.5A Effects of Equity Incentives on Firm Performance – Pooled OLS (with Equity Incentives in difference)

Variable	1992-2005 Sample Pooled OLS		2006-2009 Sample Pooled OLS	
ΔStocks	0.000	0.000*	0.022***	0.025***
	(0.000)	(0.000)	(0.004)	(0.005)
(ΔStocks)^2	1.8E^{-08}	8.4E^{-08} ***	5.8E^{-05} ***	5.7E^{-05} ***
	(0.000)	(0.000)	(0.000)	(0.000)
ΔOptions	0.001	0.001	0.002	0.002
	(0.001)	(0.001)	(0.002)	(0.001)
(ΔOptions)^2	1.2E^{-09}	4.2E^{-09}	7.8E^{-06}	4.3E^{-06}
	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-0.844***		-2.962**
		(0.050)		(1.233)
LN(S)^2		0.051***		0.185**
		(0.003)		(0.077)
K/S		-0.100***		-0.021
		(0.011)		(0.049)
(K/S)^2		0.001***		-0.009
		(0.000)		(0.006)
Sigma		-0.006***		0.002
		(0.001)		(0.008)
Sig_dum		0.325***		-0.105
		(0.044)		(0.273)
Y/S		0.015**		0.019
		(0.006)		(0.019)
(R&D)/K		-0.002		-0.073
		(0.002)		(0.061)
R&D_dum		0.467***		0.260***
		(0.014)		(0.029)

A/K		0.111*** (0.023)		0.008 (0.015)
A_dum		0.170*** (0.017)		0.160*** (0.026)
I/K		2.332*** (0.177)		-0.006** (0.003)
Adj. R^2	0.02	0.16	0.01	0.14
Wald	0.65	9.59	10.26	7.07
p-value (Wald)	0.63	0.00	0.00	0.00
AIC	357637	344133	83208	80658
BIC	357797	344405	83263	80806

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"Wald" and "p-value (Wald-test)" are test statistics and their corresponding p-values of the Wald tests for joint significance of equity incentive variables.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

TABLE 3.5B Effects of Equity Incentives on Firm Performance – Firm Fixed Effects (with Equity Incentives in difference)

Variable	1992-2005 Sample Firm Fixed Effect		2006-2009 Sample Firm Fixed Effect	
ΔStocks	0.000**	0.000***	0.009***	0.014*
	(0.000)	(0.000)	(0.003)	(0.008)
(ΔStocks)^2	1.7E^{-08} *	2.4E^{-08} ***	2.4E^{-05} ***	3.8E^{-05} **
	(0.000)	(0.000)	(0.000)	(0.000)
ΔOptions	0.001	0.001	0.002**	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
(ΔOptions)^2	2.6E^{-09}	2.4E^{-09}	3.3E^{-06}	2.5E^{-06}
	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-0.629***		-15.045
		(0.192)		(10.179)
LN(S)^2		0.029**		0.948
		(0.013)		(0.677)
K/S		-0.203***		-0.499
		(0.056)		(0.641)
(K/S)^2		0.001*		0.027
		(0.001)		(0.038)
Sigma		-0.006**		-0.043
		(0.002)		(0.035)
Sig_dum		0.193*		1.099
		(0.105)		(1.074)
Y/S		-0.015*		0.264*
		(0.009)		(0.159)
(R&D)/K		-0.002***		-0.737
		(0.001)		(0.523)
R&D_dum		-0.077		-0.015
		(0.075)		(0.123)

A/K		0.281*		0.148
		(0.156)		(0.156)
A_dum		-0.222***		0.286
		(0.071)		(0.543)
I/K		1.341**		-0.065
		(0.375)		(0.465)
Overall R^2	0.01	0.10	0.01	0.11
p-value (F-test)	0.00	0.00	0.00	0.00
Hausman	317.97	195.30	12.11	2438.17
p-value (Hausman)	0.00	0.00	0.03	0.00
Wald	4.96	4.04	4.08	2.23
p-value (Wald)	0.00	0.00	0.00	0.06
AIC	291478	288865	60564	54818
BIC	291628	289127	60611	54959

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

“p-value (F-test)” reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero.

“Hausman” and “p-value (Hausman)” report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

“Wald” and “p-value (Wald-test)” are test statistics and their corresponding p-values of the Wald tests for joint significance of equity incentive variables.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

TABLE 3.5C Effects of Equity Incentives on Firm Performance – Firm & Individual Fixed Effects (with Equity Incentives in difference)

Variable	1992-2005 Sample Firm & Invd. Fixed Effect		2006-2009 Sample Firm & Invd. Fixed Effect	
ΔStocks	0.000***	0.000***	0.013***	0.019***
	(0.000)	(0.000)	(0.003)	(0.006)
(ΔStocks)^2	2.8E^{-08} ***	3.4E^{-08} ***	2.1E^{-04} ***	7.7E^{-05}
	(0.000)	(0.000)	(0.000)	(0.000)
ΔOptions	0.001	0.001	0.003**	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
(ΔOptions)^2	2.6E^{-09} *	2.5E^{-09} *	7.7E^{-06}	9.4E^{-06}
	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-0.497***		-17.978**
		(0.126)		(7.840)
LN(S)^2		0.025***		1.129**
		(0.009)		(0.514)
K/S		-0.245***		-0.453
		(0.026)		(0.395)
(K/S)^2		0.001***		0.020
		(0.000)		(0.023)
Sigma		-0.004***		-0.052*
		(0.001)		(0.029)
Sig_dum		0.155***		1.402
		(0.059)		(0.884)
Y/S		-0.009		0.325**
		(0.006)		(0.131)
(R&D)/K		-0.001***		-0.834**
		(0.000)		(0.375)
R&D_dum		-0.085**		0.004
		(0.042)		(0.081)

A/K		0.159*** (0.046)		0.066 (0.084)
A_dum		-0.154*** (0.039)		0.470 (0.439)
I/K		1.075*** (0.175)		-0.324 (0.363)
Overall R^2	0.01	0.10	0.00	0.11
p-value (F-test)	0.00	0.00	0.00	0.00
Hausman	392.23	1190.85	54.32	3398.68
p-value (Hausman)	0.00	0.00	0.00	0.00
p-value (serial corr.)	0.00	0.00	0.00	0.00
Wald	7.52	5.46	8.24	4.07
p-value (Wald)	0.00	0.00	0.00	0.00
AIC	264704	263119	60139	52957
BIC	264854	263382	60186	53097

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported. *, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

"p-value (F-test)" reported are the significant level of F-tests for fixed effects. e.g., a p-value of 0 rejects the null hypotheses that the individual fixed effects are jointly zero.

"Hausman" and "p-value (Hausman)" report the Hausman test statistics and the corresponding p-values. e.g., a p-value of 0 rejects the null hypothesis that the difference in coefficients of within estimator and GLS estimator is not systematic.

"Wald" and "p-value (Wald-test)" are test statistics and their corresponding p-values of the Wald tests for joint significance of equity incentive variables.

"p-value (serial corr.)" reports the p-values of Wooldridge's test for serial correlation in the errors terms of panel models. e.g., a p-value of 0 rejects the null hypothesis that there is no first order autocorrelation in the error terms.

AIC and BIC report the Akaike information criterion and Bayesian information criterion, which are model selection criteria. Models with smaller AIC values and BIC values are more preferable.

TABLE 3.7A Effects of Equity Incentives on Firm Performance in Dynamic Panel Setting – Firm & Individual Fixed Effects (using Difference GMM, lagged Equity Var.)

Variable	1992-2005 Sample (Diff. GMM with 2 lags)		1992-2005 Sample (Diff. GMM with 3 lags)		2006-2009 Sample (Diff. GMM with 2 lags)	
lag Q	0.253***	0.191***	0.252***	0.015	1.353***	1.104***
	(0.061)	(0.064)	(0.074)	(0.137)	(0.178)	(0.296)
lag Stocks	-0.248	-0.445	-0.156	-0.298	-0.254	-0.441
	(0.206)	(0.327)	(0.161)	(0.277)	(0.217)	(0.303)
(lag Stocks)^2	$1.8E^{-05}$	$6.8E^{-05}$	$2.4E^{-07}$	$4.4E^{-05}$	$1.1E^{-04}$	$1.1E^{-03}$
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
lag Options	-0.019*	-0.010	-0.012	-0.007	0.018	0.011
	(0.011)	(0.012)	(0.012)	(0.013)	(0.032)	(0.025)
(lag Options)^2	$9.7E^{-07}$	$1.4E^{-06}$	$3.7E^{-07}$	$7.8E^{-07}$	$-4.5E^{-05}$	$-3.8E^{-05}$
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-6.898**		-13.077***		-6.930
		(3.340)		(4.813)		(7.557)
LN(S)^2		0.307		0.806***		0.691
		(0.306)		(0.392)		(0.643)
K/S		-1.390		-0.837		-2.406
		(1.316)		(1.188)		(4.219)
(K/S)^2		-0.001		-0.002		0.452
		(0.014)		(0.015)		(0.604)
Sigma		-0.006		-0.009		-0.040
		(0.017)		(0.018)		(0.092)
Sig_dum		0.799		1.680		1.217
		(1.806)		(1.661)		(4.036)
Y/S		-0.064		0.150		0.055
		(0.144)		(0.092)		(0.819)
(R&D)/K		-0.006		0.037		0.319
		(0.042)		(0.063)		(0.585)

R&D_dum		-4.236		12.325***		2.003
		(4.423)		(7.039)		(4.294)
A/K		10.718**		12.763**		-1.434
		(4.215)		(5.382)		(1.548)
A_dum		-4.210*		-1.187		5.001
		(2.509)		(3.078)		(3.257)
I/K		1.414		7.175*		-9.239
		(2.247)		(3.996)		(6.441)
Wald	5.42	3.31	3.47	1.96	1.83	2.60
p-Wald	0.25	0.51	0.48	0.74	0.77	0.63
p-Sargan	0.00	0.00	0.00	0.00	0.00	0.02
p-Hansen	0.00	0.01	0.00	0.02	0.63	0.88
p-MA(1)	0.50	0.63	0.05	0.40	0.01	0.65
p-MA(2)	0.77	0.78	0.66	0.93	0.73	0.12

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported.

*, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

Wald-test results are used to test the joint significance of the four equity incentive variables, and p-value (Wald) reported are the corresponding significant levels.

“p-Sagan” and “p-Hansen” report the p-value of the tests for over-identifying restrictions. A rejection of the null in these tests means that the instruments are not exclusively affecting the outcome of interest though the endogenous variable.

“p-MA(1)” and “p-MA(2)” report the p-value of the tests for first order and second order serial correlation, respectively. “p-MA(1)” reports the probability of the test statistics show the differenced error terms follow an MA(1) process, when the true process is not. “p-MA(2)” is interpreted analogously.

TABLE 3.7B Effects of Equity Incentives on Firm Performance in Dynamic Panel Setting – Firm & Individual Fixed Effects (using System GMM, lagged Equity Var.)

Variable	1992-2005 Sample (Sys. GMM with 2 lags)		1992-2005 Sample (Sys. GMM with 3 lags)		2006-2009 Sample (Sys. GMM with 2 lags)	
lag Q	0.364***	0.175***	0.761***	0.285*	1.887***	0.811***
	(0.078)	(0.062)	(0.152)	(0.146)	(0.085)	(0.225)
lag Stocks	0.248	-0.186	0.381**	-0.354	-0.766	-0.528
	(0.194)	(0.174)	(0.171)	(0.322)	(0.436)	(0.307)
lag Stocks^2	-4.3E^{-05}	1.6E^{-05}	-6.6E^{-05} **	8.0E^{-05}	1.1E^{-04}	8.6E^{-04}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
lag Options	0.013	-0.009	-0.040**	-0.008	-0.041	0.018
	(0.013)	(0.010)	(0.016)	(0.017)	(0.051)	(0.030)
lag Options^2	-3.4E^{-06}	-6.4E^{-07}	1.9E^{-06} *	1.2E^{-06}	1.3E^{-04}	-4.4E^{-05}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LN(S)		-8.674***		-10.797***		-17.278***
		(2.113)		(3.391)		(3.360)
LN(S)^2		0.780***		0.845***		1.195***
		(0.190)		(0.267)		(0.290)
K/S		-5.153***		-0.116		-2.966
		(1.454)		(1.405)		(4.690)
(K/S)^2		0.032**		-0.009		0.384
		(0.014)		(0.015)		(0.550)
Sigma		0.029*		0.058*		-0.114*
		(0.016)		(0.032)		(0.067)
Sig_dum		0.328		-4.804*		3.505
		(1.428)		(2.825)		(2.753)
Y/S		-0.194		-0.088		1.187
		(0.248)		(0.192)		(0.797)
(R&D)/K		-0.074		0.002		-0.158
		(0.082)		(0.054)		(0.510)

R&D_dum		4.050**		0.271		-4.362
		(1.650)		(2.832)		(3.930)
A/K		4.702**		19.287***		-0.640
		(2.209)		(7.071)		(1.088)
A_dum		-0.314		-8.896***		6.916**
		(1.517)		(2.831)		(3.408)
I/K		5.855***		3.912		-5.849
		(2.113)		(3.511)		(5.272)
Wald	4.44	2.78	10.18	1.71	5.19	3.34
p-Wald	0.35	0.59	0.04	0.79	0.27	0.50
p-Sargan	0.00	0.00	0.00	0.00	0.00	0.02
p-Hansen	0.00	0.00	0.00	0.21	0.23	0.84
p-MA(1)	0.00	0.03	0.44	0.11	0.00	0.10
p-MA(2)	0.70	0.77	0.65	0.81	0.04	0.06

Source: Compiled by author.

Note: Standard deviations are reported in parentheses. They are robust to heteroskedasticity. Intercept terms and year dummies are included for all regressions but not reported.

*, **, *** indicate statistically significance at the 10% level, 5%level, and 1% level respectively.

Wald-test results are used to test the joint significance of the four equity incentive variables, and p-value (Wald) reported are the corresponding significant levels.

“p-Sagan” and “p-Hansen” report the p-value of the tests for over-identifying restrictions. A rejection of the null in these tests means that the instruments are not exclusively affecting the outcome of interest though the endogenous variable.

“p-MA(1)” and “p-MA(2)” report the p-value of the tests for first order and second order serial correlation, respectively. “p-MA(1)” reports the probability of the test statistics show the differenced error terms follow an MA(1) process, when the true process is not. “p-MA(2)” is interpreted analogously.